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SULPHIDE DEPT. FILES

FURUKAWA MINING COMPANY.

Printed by the Tokyo Printing Co., Ltd.

TRADE MARK

Exhibits of the Japan-British Exhibition.

Ores, Copper Ingots, Copper Wires. Coal,

Coke and other products

of the

Furukawa Mining Company.

BRIEF DESCRIPTIONS

FOR

MINES, COPPER WORKS AND COKE MANUFACTORY

OF

FURUKAWA MINING COMPANY.

TOKYO, JAPAN.
1910.

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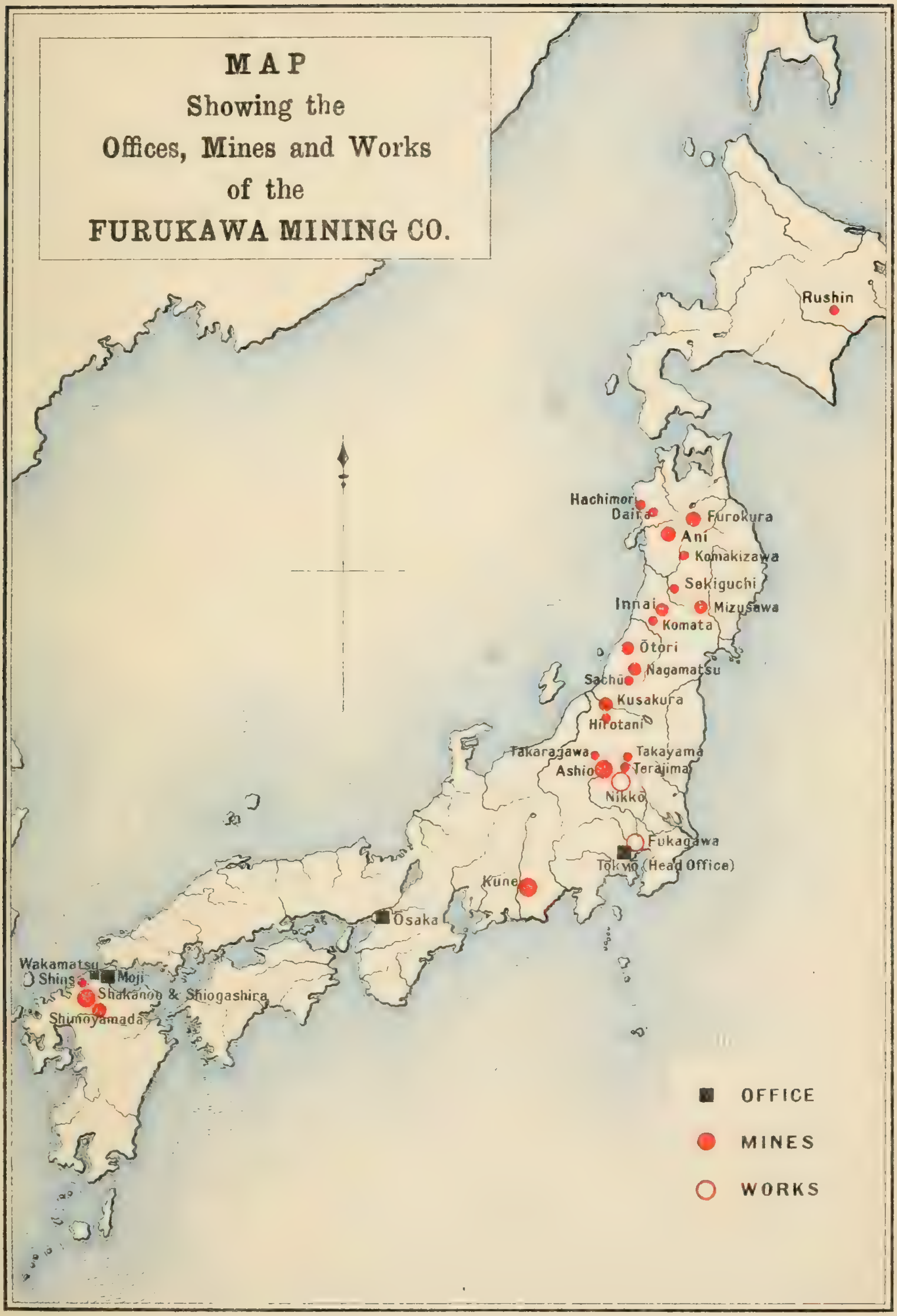


MAP
Showing the
Offices, Mines and Works
of the
FURUKAWA MINING CO.

Furukawa Mining Company.

Introductory Note.

IT is now 34 years over since the late Ichibei Furukawa originally established the Copper Firm in 7 Setomonochō, Nihonbashi-ku, Tokyō. He was a very energetic man at developing mines and spent millions of money to open and equip the mines he had prospected. He gave his firm a vigorous organization and thanks to his efforts the company now stands in the front rank among the largest copper producers of the globe. In 1903, the late Junkichi Furukawa, the son of the founder, succeeded his father as the president of the firm and assumed the management of the business. In April 1903, the concern was made into a mining company under the Japanese law with a capitalization of 5,000,000 *Yen*. Upon the demise of the late J. Furukawa in 1906, Toranosuke Furukawa succeeded his brother and became the chief partner and the president of the company, and under the new management many economies in operation are being effected. The partners are now three, viz. Toranosuke Furukawa, Chōshichi Kimura and Baron Kumakichi Nakashima. The total area of the concession of the company is about 26,500 acres, working with 1400 officials and 22,000 men with a production of some 14,000 tons of copper, 700,000 ounces of gold and silver, 500,000 tons of coal, 30,000 tons of coke etc. a year.

While recognizing that the management of the president T. Furukawa goes on with unabated energy, it must be remembered that the late I. Furukawa was the pioneer who developed the mines and that the late J. Furukawa was the first leader of our company.

The company has been honoured with 15 medals by several exhibitions at home and abroad. The principal medals are as follows :

GOLD MEDAL by the Tokyō Industrial Exhibition in 1887.

GOLD MEDAL OF HONOUR by the Third National Exhibition, Tōkyō in 1890.

GOLD MEDAL OF HONOUR by the Fourth National Exhibition, Kyōto in 1895.

GRAND PRIX by the *Exposition Universelle Internationale* Paris in 1900.

GOLD MEDAL OF HONOUR by the Fifth National Exhibition, Ōsaka in 1903.

MEDAILLE COMMEMORATIVE by the *Exposition de Hanoï* in 1902—1903.

GRAND PRIZE by the Louisiana Purchase Exposition, Saint Louis in 1904.

COMMEMORATIVE MEDAL by the Louisiana Purchase Exposition, Saint Louis in 1904.

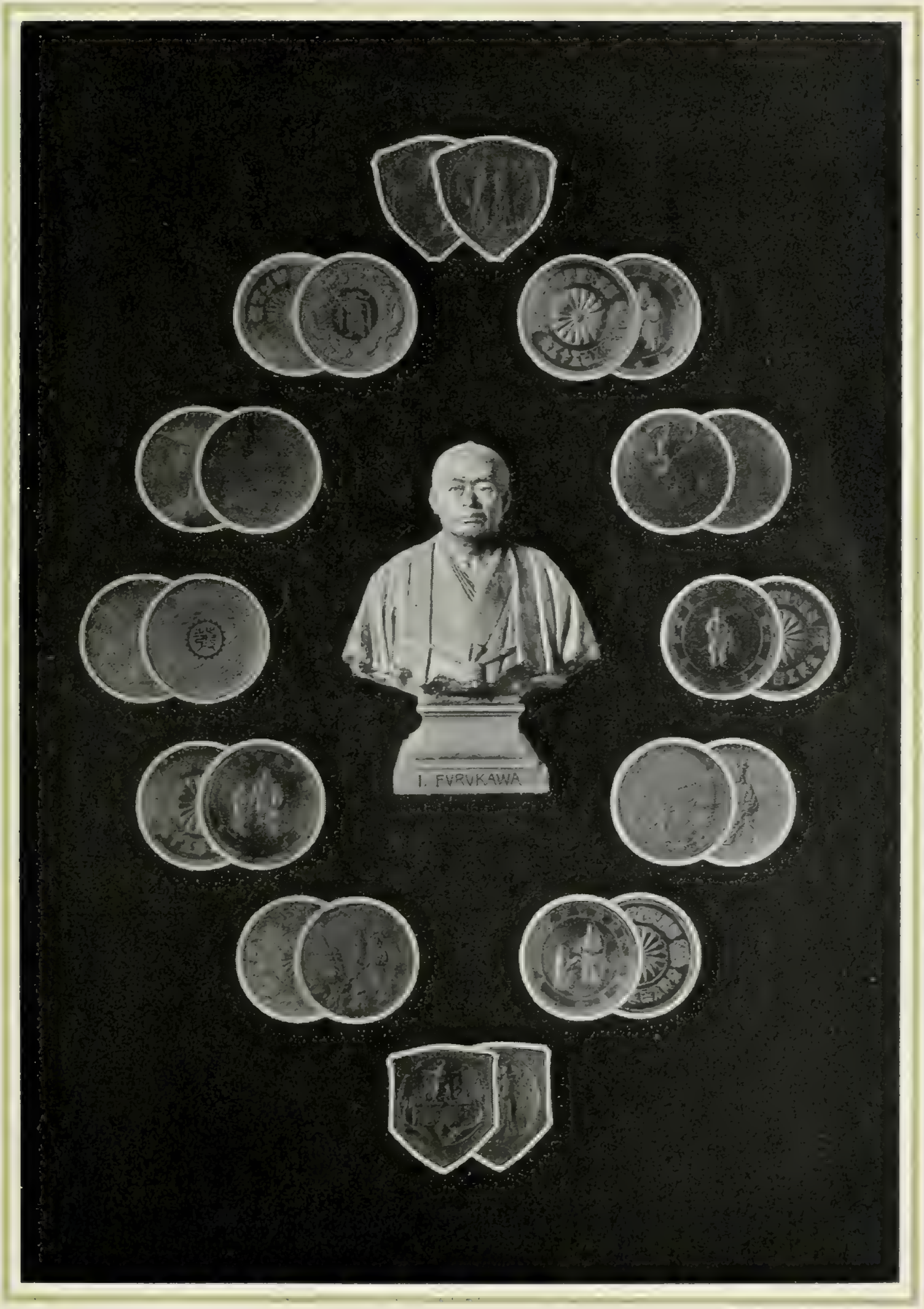
GOLD MEDAL OF HONOUR by the Tōkyō Industrial Exhibition in 1908.

SILVER MEDAL by the Exhibition of Invention, Tōkyō in 1909.

etc. etc.

The officers of the company are :

Toranosuke Furukawa, President.
Chōshichi Kimura, Chief Director.
Rokusaburō Kondō, Director.
Kunisuke Okazaki, Director.
Masayuki Otagawa, Chief of Mining and Engineering Department.
Baron Kumakichi Nakashima, Chief of Commercial Department.
Bunjirō Konda, Secretary.
Kametarō Iijima, Treasurer.


I. FVRVKAWA

Head Office of Furukawa Mining Co., Tōkyō.

Moji Sales Office.

Ōsaka Sales Office.

Shanghai Sales Office.

The Furukawa Mining Company Properties.

HEAD OFFICE: 1 Yaesucho Itchōme, Kōjimachi-ku, Tōkyō.

BRANCHES:

Moji Sales Office : 7 Hamamachi, Moji.
Wakamatsu Branch Office : Kaigan-dōri Nichōme, Wakamatsu.
Ōsaka Sales Office : 26 Edobori Minamidōri Sanchōme, Ōsaka.
Shanghai Sales Office : 3 Peking Road, British Concession, Shanghai.

MINES:

Ashio Copper Mines : Ashio, Tochigiken.
Ani Copper Mines : Ani, Akitaken.
Furokura Copper Mines : Ōyu-mura, Akitaken.
Mizusawa Copper Mines : Iwasaki-mura, Iwateken.
Kusakura Copper Mines : Ryōganose-mura, Niigataken.
Hirotani Copper Mines : Nishikawa-mura, Niigataken.
Nagamatsu Copper Mines. Ōkura-mura, Yamagataken.
Sachū Copper Mines : Shiraiwa-machi, Yamagataken.
Ōtori Copper Mines : Ōizumi-mura, Yamagataken.
Komakizawa Copper Mines : Hinokinai-mura, Akitaken.
Komata Copper Mines : Araki-mura, Yamagataken.
Sekiguchi Copper Mines : Sanseki-mura, Akitaken.
Takaragawa Copper Mines : Minagami-mura, Gunmaken.
Takayama Copper Mines : Tamanyū-mura, Tochigiken.
Kune Copper Mines : Sakuma-mura, Shizuokaken.
Innai Silver Mines : Innai, Akitaken.
Hachimori Silver Mines : Hachimori-mura, Akitaken.
Daira Lead Mines : Fujikoto-mura, Akitaken.
Terajima Gold Mines : Tamanyū-mura, Tochigiken.
Shakanoo and Shiogashira Coal Mines : Ōtani-mura, Fukuokaken.
Shimoyamada Coal Mines : Kumada-mura, Fukuokaken.
Shinshakanoo Coal Mines : Nishikawa-mura, Fukuokaken.
Rushin Coal Mines : Tokachi, Hokkaidō.

WORKS:

Nikkō Copper Works : Nikkō, Tochigiken.
Fukagawa Coke Works : Fukagawa, Tōkyō.

Ashio Copper Mines.

(Annual production 7,000 tons of copper)

Location.

The Ashio Copper Mines are in the town of Ashio in Tochigiken, about 18 miles from Nikkō.

The area of the concession is 1,500 acres. The mines are divided into three, viz. Honzan, Kotaki, and Tsūdō, which are distant three miles from each other. Each has its own dressing plant, and the reduction works are at Honzan while the copper works are established in Nikkō.

History.

The Ashio Copper Mines were discovered in 1609 and were a producer in 1611. Under the administration of our government, they were developed to reach a productive capacity of about 150 tons of copper yearly in the latter half or seventeenth century, but unfortunately in the nineteenth century it was decreased again. In 1871, they were transferred to private hands, and in 1877, the property at last came into the possession of the late Ichibei Furukawa, the father of the president, in such poor condition that the yield was only 52 tons of the copper a year.

By the vigorous efforts and careful administration of the late I. Furukawa and his successors, the mines were brought up to the present state—the largest copper mines in the Empire,—reaching an annual productive capacity of 7,000 tons.

In 1905, the Nikkō Copper Works were founded with the object of refining the bessemer copper from Ashio Copper Mines as well as the blister coppers from other mines of our company. In 1908, they absorbed the Honjō Copper Works of our company, and now manufacture electrolytic copper, bars, wire, etc.

General View of Tsūdō Mine, Ashio.

Geology and Ore Deposit.

The district of Ashio consists of chiefly Paleozoics and liparite. The Paleozoics are composed of slate, quartzite and limestone. The liparite is a volcanic neck erupted through the Paleozoics and is more than 2 miles in diameter.

The ore deposit of Ashio Mines is veins, most of which traverse the liparite, but the remainder run in the liparite as well as the Paleozoics, or in the Paleozoics only. The dip of the veins is mostly very steep, and the strike is classified into two, viz. (I) N 50°–60° E and (II) N 80°–85° W. The veins on the first strike are called the sixty degree, or Yokomabu Series, and the others are the hundred degree or Shinsei Series.

The mines have more than 200 lodes, and among them 30 of the Yokomabu Series and 40 of the Shinsei Series are now being worked. The fissures of both series of veins are broken out simultaneously by the lateral pressure which folded the main mountain system of the north arc of Japan. They intersect with each other and form rhombic nets of veins. The lodes are generally 1–16 ft. thick and 400–6,000 ft. long.

The chief constituents of the veins are chalcopyrite and pyrite; and quartz as a vein stuff. Besides, zincblende, arsenopyrite, galena, and pyrrhotite frequently occur. Bornite, chalcosite, cuprite, malachite, pisanite, sometimes azurite and native copper are all found in the oxidized zone. Besides quartz as a vein stuff, there are found calcite, and sometimes gypsum, which is the secondary mineral. Very rarely fluorite, crystallized vivianite, ludlamite, wolframite, and apatite are found.

The working lodes of the mines will be described as follows:

Yokomabu Series.

To begin from the north:—Ginsei, Jimbō, Ashikura, Ebisu, Yokomabu, Nakamine, Hōsei, Benten, Ōdate-maehi, Ensei, 2nd. branch of Kōsei-maehi, No. 2 Kisei, Kisei, Tsūsei, 1st. branch of Kōsei-maehi, Kōsei, Ryūsei, Eisei, Daikoku, Rensei, Kyokusei, No. 3 Ōgiri, Chokusei, Ōgiri-shitabanhi, 1st. Fukusei, No. 33 Tsūdō, No. 32 Tsūdo, No. 2 Tengu, 2nd. Fukusei, No. 25 Tsūdō, Bannemonhi, Yasubeihi, No. 7

Honbankō, No. 1 Honbankō, No. 6 Tsūdo, Deai, 4th. Uwabanhi of Sunokobashi, etc.

Yokomabu is the champion lode, 6,000 ft. long, and the next is Kōsei, having 3,000 ft. in strike. The veins of Jimbō, Yasubeihi, and Deai are more than 2,000 ft. long.

Shinsei Series.

To begin from the north :—Bannemon-utorihi, Hōsei-machi, Eisei, Shinsei, Chūsei, No. 3 Taisei, No. 27 Honkuchi, Eisei-utorihi, No. 23 Kotaki-ōtateire, No. 20 Kotaki-ōtateire, Ōgirihi, Shijūichinenhi, Shijūnenhi, Oku-utorihi, Mae-utorihi, Kōsei-maehi, No. 23 Tsūdō, Tengu, 2nd. Uwabanhi of Sunokobashi, etc.

Among them, Kosei-maehi, and Tengu are the largest, supposedly the same vein, and their total length is 4,500 ft. Eisei and Shinsei are more than 2,000 ft. long.

Mining.

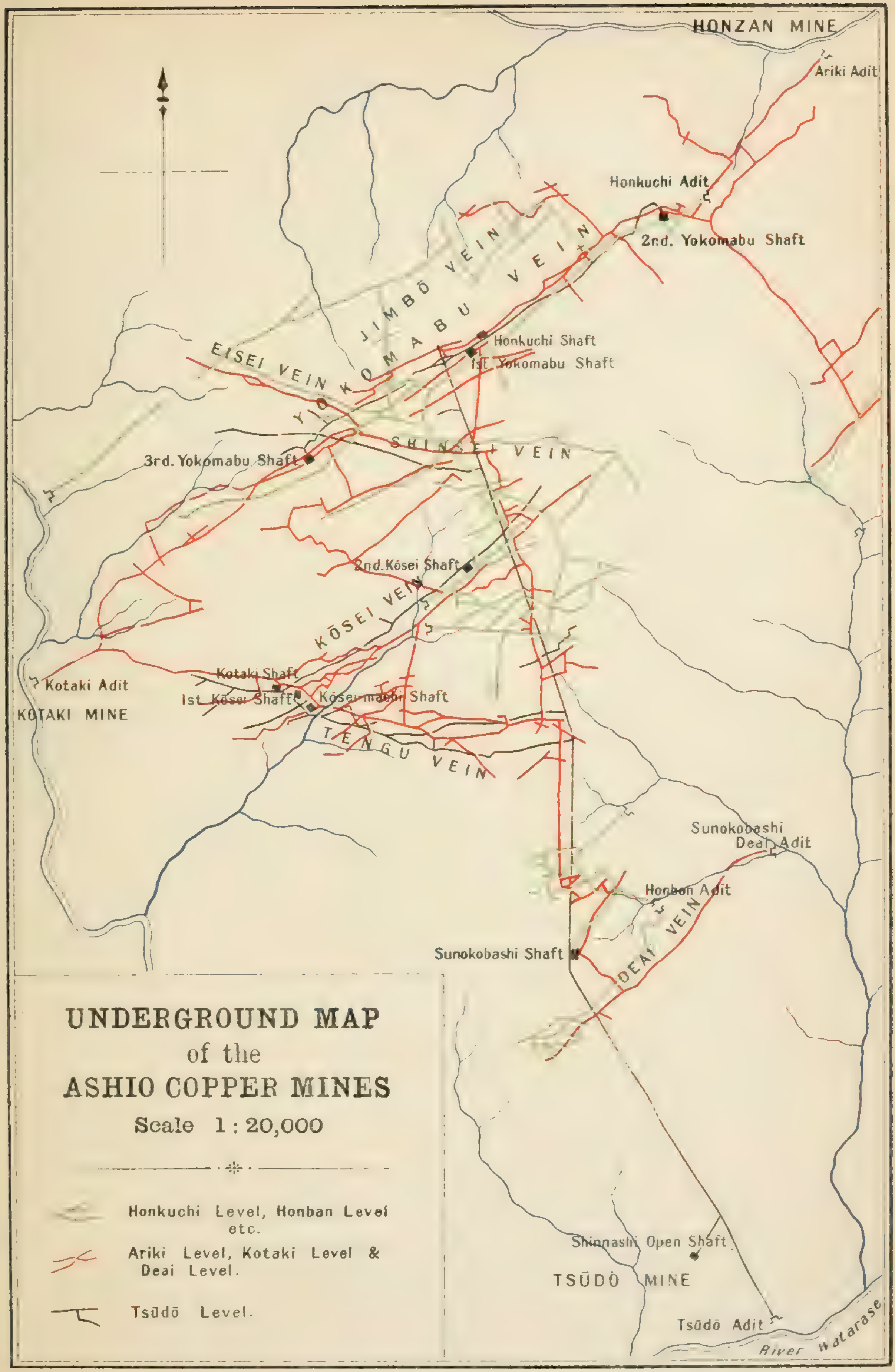
Main Leavels and Shafts. The three mines of Honzan, Kotaki, and Tsūdō communicate with each other by levels and shafts, of which a few principal ones will be briefly described in the following lines :

Honzan Mine.

Ariki level :—The adit is situated at the north-eastern foot of Bizendate Peak. The level is driven mainly along the strike of Yokomabu-vein, and is 10 ft. high, 10 ft. wide and about 7,000 ft. long. It is the most important level for transportation and drainage in Honzan Mine.

Honkuchi level :—The level is older than Ariki, and is 300 ft. above Ariki level, being numbered to be the fourth level from the latter. It is also driven along the strike of Yokomabu vein, and is 7 ft. high, 8 ft. wide, and 6,000 ft. long. In the upper part of this level, there are more than 10 levels and many working places can be seen.

Honkuchi shaft :—The shaft (6 ft. × 9 ft.) is situated about 2,600 ft. from the mouth of the Honkuchi level, and reaches Ariki level.



UNDERGROUND MAP
of the
ASHIO COPPER MINES
Scale 1 : 20,000

1st. and 2nd. Yokomabu shafts:—1st. Yokomabu shaft (6 ft. × 11 ft.) and 2nd. Yokomabu shaft (6 ft. × 18 ft.) are situated on Yokomabu vein at a distance of 4,600 ft. and 2,500 ft. respectively from Ariki adit, whence at a depth of 457 ft. and 410 ft. they reach Tsūdo level. A winding apparatus is fitted up in each shaft. There are 7 levels and many working places which are now being operated prosperously.

3rd. Yokomabu shaft:—The shaft (5 ft. × 12 ft.) is 1,900 ft. from 1st. Yokomabu shaft and passes through Tsūdō level at 466 ft. below Ariki level, and moreover further sinking is going on. Winding apparatus is provided in this shaft mouth for the working below Tsūdō level.

Kotaki Mine.

Kotaki level:—The adit is situated at the south western foot of Bizendate Peak, and 45 ft. below the Ariki adit. It is driven chiefly along the strikes of Kōsei, and Tengu vein, and connected with Ariki level. It is the lowest and also the most important for transportation and drainage in Kotaki Mine. Both Kotaki and Ariki levels are used as a trunk line for the underground communication between Honzan and Kotaki Mines. There are 12 levels above this level and 6 levels below within the reach of Tsūdō level.

Kotaki shaft:—The shaft (6 ft. × 14 ft.) is situated near Kosei vein and at a distance of 2,100 ft. from Kotaki adit, and it reaches Tsūdō level at a depth of 405 ft.

Tsūdō Mine.

Tsūdō main adit:—The adit is located on the bank of the River Watarase, and is 475 ft. lower than Ariki level. The driving of the level began in 1885 and the level reached Yokomabu vein in 1895, after having proceeded on about 10,000 ft. toward north. More than fifty veins were cut during the driving and most of them are working prosperously now.

It is the main drainage and transportation level at present, being 11 ft. high and 13 ft. wide.

Honban level:—At a height of 620 ft. from Tsūdō adit, we can find this Honban level. There are 7 levels below it, and 2 levels above it.

Shinnashi shaft :—The shaft (9 ft. × 12 ft.) opens near Tsūdō dressing plant, being 107 ft. deep, and communicates with Tsūdō adit at a distance about 800 ft. from this adit mouth. The shaft is used for winding crude ores and rubbish.

1st. Kosei shaft :—The shaft (6 ft. × 18 ft.) is very near Kōsei vein, and is situated at a distance of 2,600 ft. along the No. 23 vein westward from the Tsūdō adit. The depth of this shaft is 843 ft. at present and further sinking is now in progress. There are 7 levels connecting with this shaft for the working of the veins Kōsei, Kōsei-maehi, Tengu, Rensei etc.

2nd. Kōsei shaft :—The shaft (6 ft. × 18 ft.) is located at a distance of 2,000 ft. westward from 1st. Kōsei shaft along the vein Kōsei. It is 420 ft. deep. There are 4 levels connecting with the shaft for the working of eastern part of the vein.

Kōsei-maehi shaft :—The shaft (6 ft. × 23 ft.) is situated on the vein Kōsei-maehi ; and the present depth is 352 ft. below the Tsūdō adit. Further sinking is now in progress.

The total length of levels in use is as follows :

Honzan Mine	270,000 ft.
Kotaki Mine	160,000 ft.
Tsūdō Mine	130,000 ft.
Total	560,000 ft.

The vertical extent of the veins—from the highest outcrop to the lowest level—being now excavated is as follows :

Outcrop on Bizendate Peak to Tsūdō adit.	2,200 ft.
Below Tsūdō adit	800 ft.
Total	3,000 ft.

Prospecting and Working methods. The prospecting is chiefly done by level driving with a size of 4 ft. × 7 ft. either along the vein, or crosscutting with an interval of 60 ft. in height. As to the lower part of the Tsūdō adit, the level driving is commenced in the same way from the shaft at a rate of 110 ft.

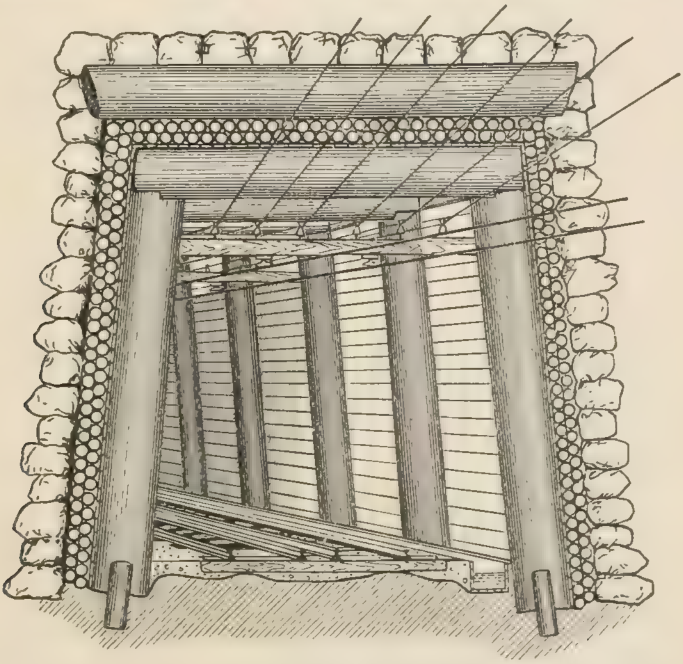
Overhand stoping is generally adopted here, and sometimes underhand stoping and *Nukibori* (special working for the richer part of vein) are used. Each stope is 6 ft. high and more than 2½ ft. wide varying according to the thickness of the vein being worked.

The excavation is chiefly done by hand, but the rockdrill is used to some extent in driving, sinking etc. There are several kinds of rockdrills in use, for instance, Water Leyner, Little Wonder and others.

The present numbers of workings and miners are as follows :

Prospecting	450 places,	1,000 men.
Stoping	1,000 places,	1,600 men.
Nukibori	40 places,	150 men.
Total	1,490 places,	2,750 men.

Timbering. As the materials of timbering, only rough round logs are used in the mines. There are several forms of timberings such as simple legs and cap, saddle back, and polygonal shape, each being used according to circumstances. It is quite interesting to write that large excavated spaces such as the winding and pumping rooms, about 40 ft. wide, about 25 ft. high, are well timbered with big logs.



The exhibit of timbering from the Mining Bureau of Japan, which is used as a background to the model figures of miners shows the single set of an ordinary level timbering of the mines.

Transportation underground. The ores, rubbish, and various supplies are transported by electric locomotives, electric windings, and other means according to circumstances.

The electric locomotives are widely adopted in the three main levels of Ariki, Kotaki, and Tsūdō. The ores of the mines Kotaki and Honzan, directly, and those of Tsūdō after being wound up through Shinnashi shaft, are transported to their own dressing plants. The rubbish of Honzan and Tsūdō is transported directly to the dump, while that of Kotaki is brought to the ropeway terminal, whence it is sent to the dump.

Winding machines are equipped in all the shafts in the mines, and the following is a brief description of them.

Name.		depth.	type.	H.P.
1st. Yokomabu	shaft.	495 ft.	Electric doube drum.	40.
2nd. Yokomabu	,,	637 ft.	,,	50.
3rd. Yokomabu	,,	933 ft.	,,	50.
Honkuchi	,,	295 ft.	Self acting drum.	
Kotaki	,,	588 ft.	Electric double drum.	50.
1st. Kōsei	,,	843 ft.	,,	100.
2nd. Kōsei	,,	420 ft.	,,	75.
Kōsei-maehi	,,	352 ft.	,, (temporary.)	25.
Sunokobashi	,,	337 ft.	,,	35.
Shinnashi	,,	107 ft.	,,	80.

Ariki Adit.

Tsūdō Adit.

Pumping and Drainage. The Ariki and the Kotaki levels are used to drain out the mine water coming from the above but the rest of the water is drained out from the Tsūdō adit.

There are a great number of pumps of which the principal are as follows :

Site.	type.	No.	H.P.
1st. Kōsei shaft.	Sulzer two stage turbine pump.	3	50.
,,	Riedler single differential pump.	3	100.
,,	,, ,, ,,	1	75.
,,	Escher-Wyss turbine pump.	1	75.
,,	Knowles vertical pump.	2	25.
,,	Special rod pump.	2	30.
2nd. Kōsei shaft.	Blake pump.	1	50.
,,	Knowles pump.	2	15.
3rd. Yokomabu shaft.	Escher-wyss turbine pump.	3	75.
,,	Knowles vertical pump.	2	15.
2nd. Yokomabu shaft.	Tanaka's vertical pump.	2	15.
,,	Knowles vertical pump.	1	25.
,,	Knowles sinking pump.	1	5.
,,	Blake rod sinking pump.	2	50.

Ventilation. The ventilation is secured by the natural draught but sometimes the circulation is helped by the means of regulating doors, wind boxes etc. The wider the extension below the Tsōdō adit become, the more the difficulties of the ventilation increase, and centrifugal fans are used for blowing in the fresh air.

Lighting. The main levels, the pumping and winding stations and the watch houses are illuminated by electric light. Each miner carries a small seed-oil lamp with a naked light.

Transmission of Electricity in the mine. All the machinery in the mines is driven by electricity. 11,000 volt alternating current from Hosoo hydro-electric power plant is transmitted into three substations—Matō, Kotaki and Sunokobashi—where it is transformed down to 2,200 volts. In the Mato the 2,200 volt alternating current is partly converted to direct current of 450 volts, which is used for the driving of tramway locomotives and the winding machines in Honzan Mine. The 2,200 volt alternating current from Sunokobashi substation is transformed down again to 500 volts near the 2nd. Kōsei shaft, whence it is transmitted to several machines thereabouts. The alternating current from Kotaki substation is also stepped down to 500 volt near 1st. Kōsei shaft for the driving of several machines in Tsūdō Mine. The power for Kotaki Mine is supplied from Kotaki substation. The mine locomotives in Tsūdō Mine are driven by direct current of 450 volts from the Tsūdō power plant.

For the transmission of 500 and 2,200 volt alternating current, steel armoured paper cables and lead covered paper cables are used. The length of the cables for 2,200 volt alternating current is 32,000 ft., and that for 500 volt is 11,000 ft.

Dressing.

Crude ores here in the mines are classified into two kinds ; 1st. grade and 2nd. grade. The former is rich ore sorted underground and carries 12% copper on the average. The latter averages 1% copper more or less.

The daily output of crude ores from the three mines is as follows :

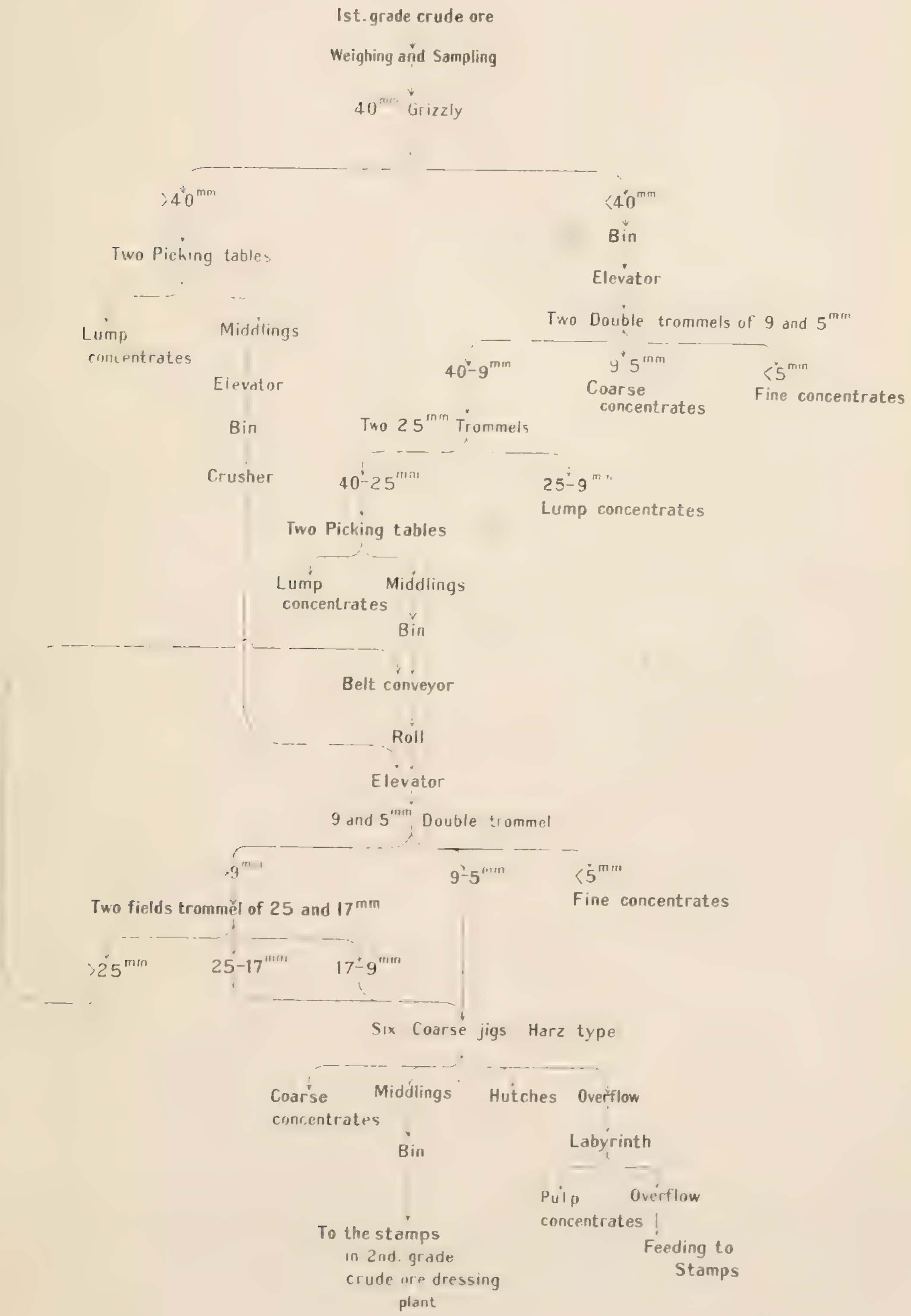
	quantity	% of copper	copper content
1st. grade.	145 tons.	12.4	17.4 tons.
2nd. ,,	610 ,,	1.0	6.1 ,,

Three mines have their own dressing plants, and the dry and wet processes are adopted in these plants. The operation is described in the accompanying schemes.

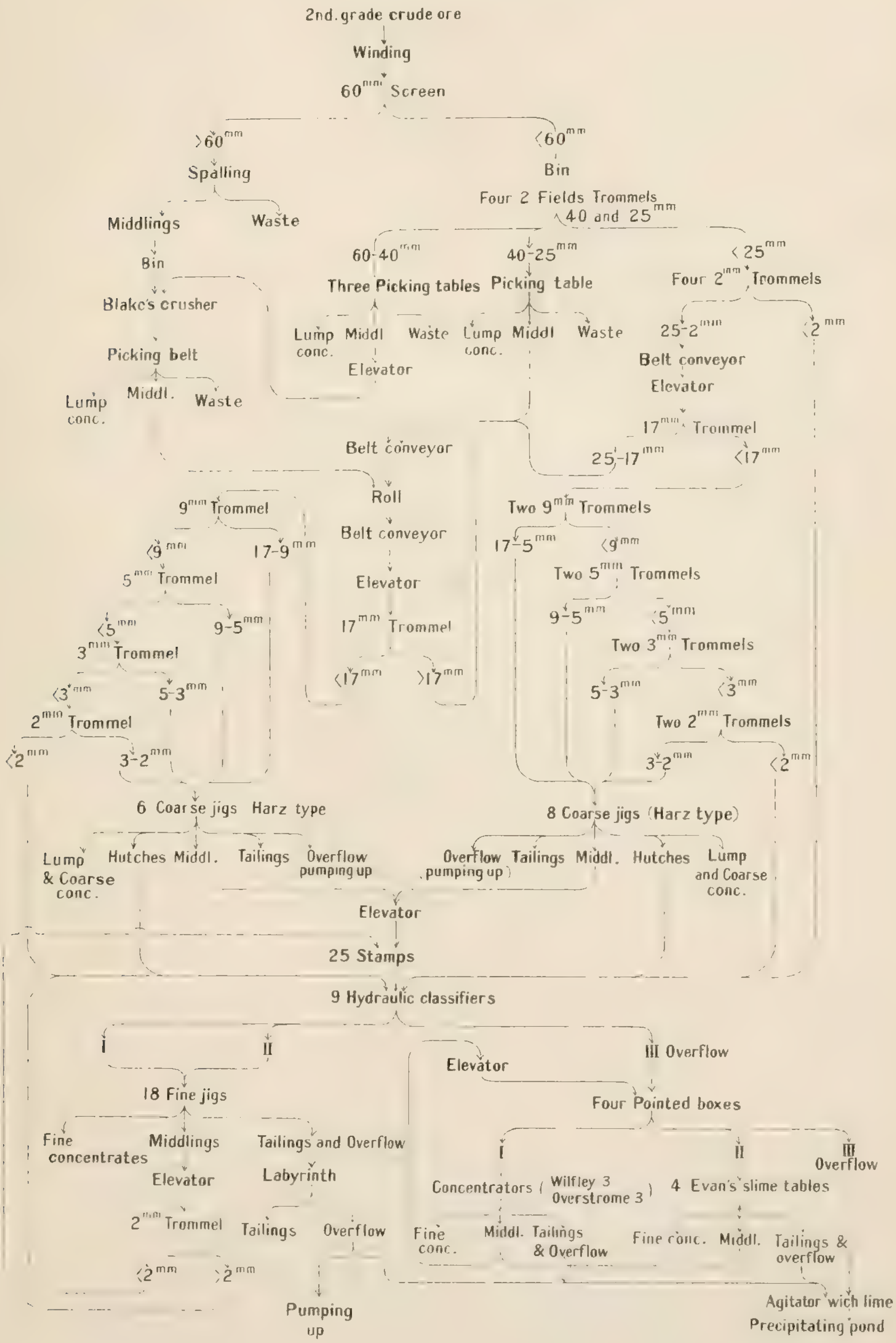
The driving of the machinery of the dressing plants is chiefly done by electricity.

The concentrates from these plants are 170 tons daily on 12% copper.

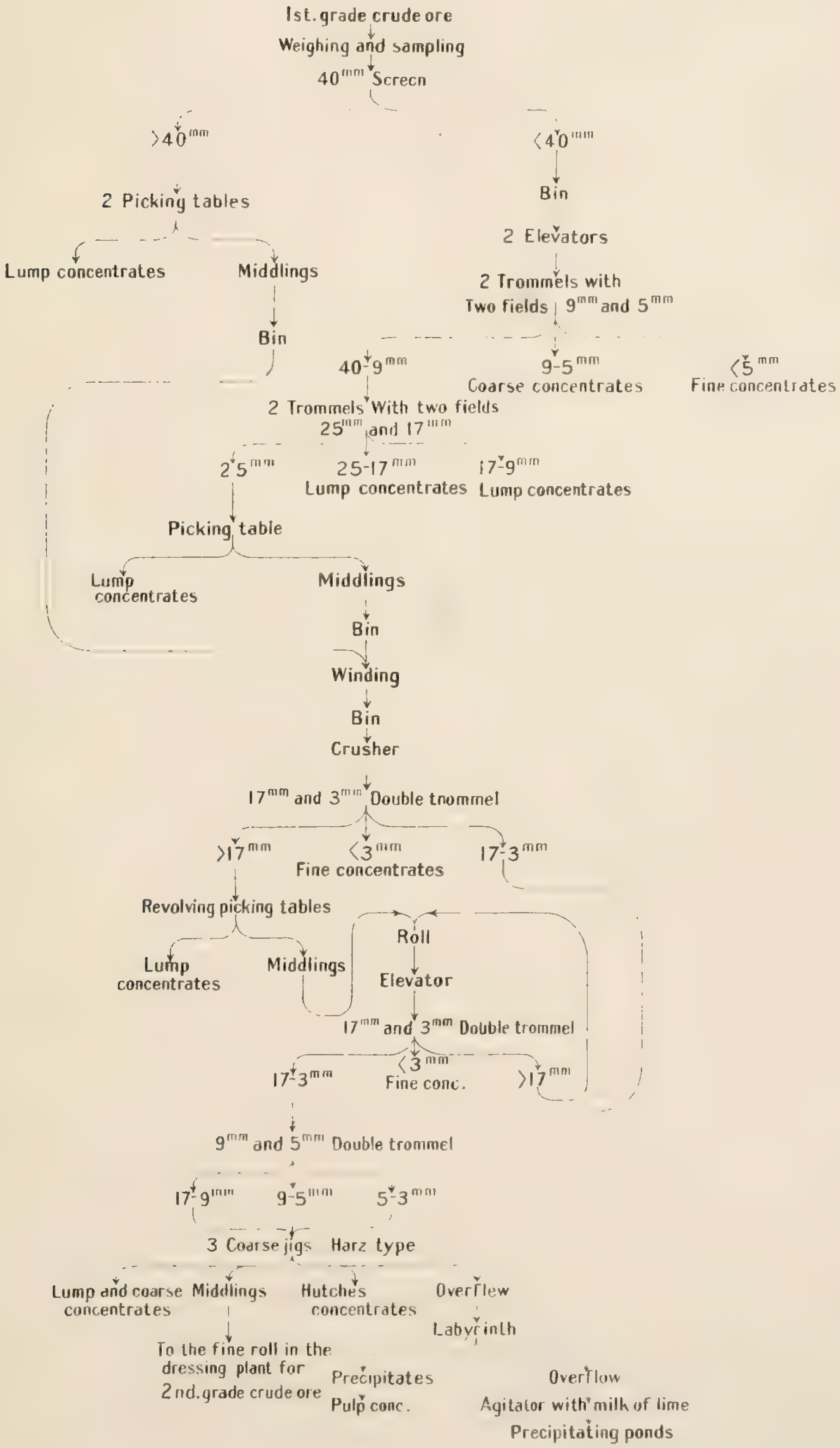
Scheme of Honzan Dressing Plant, Ashio Copper Mines.
(For first grade crude ore)



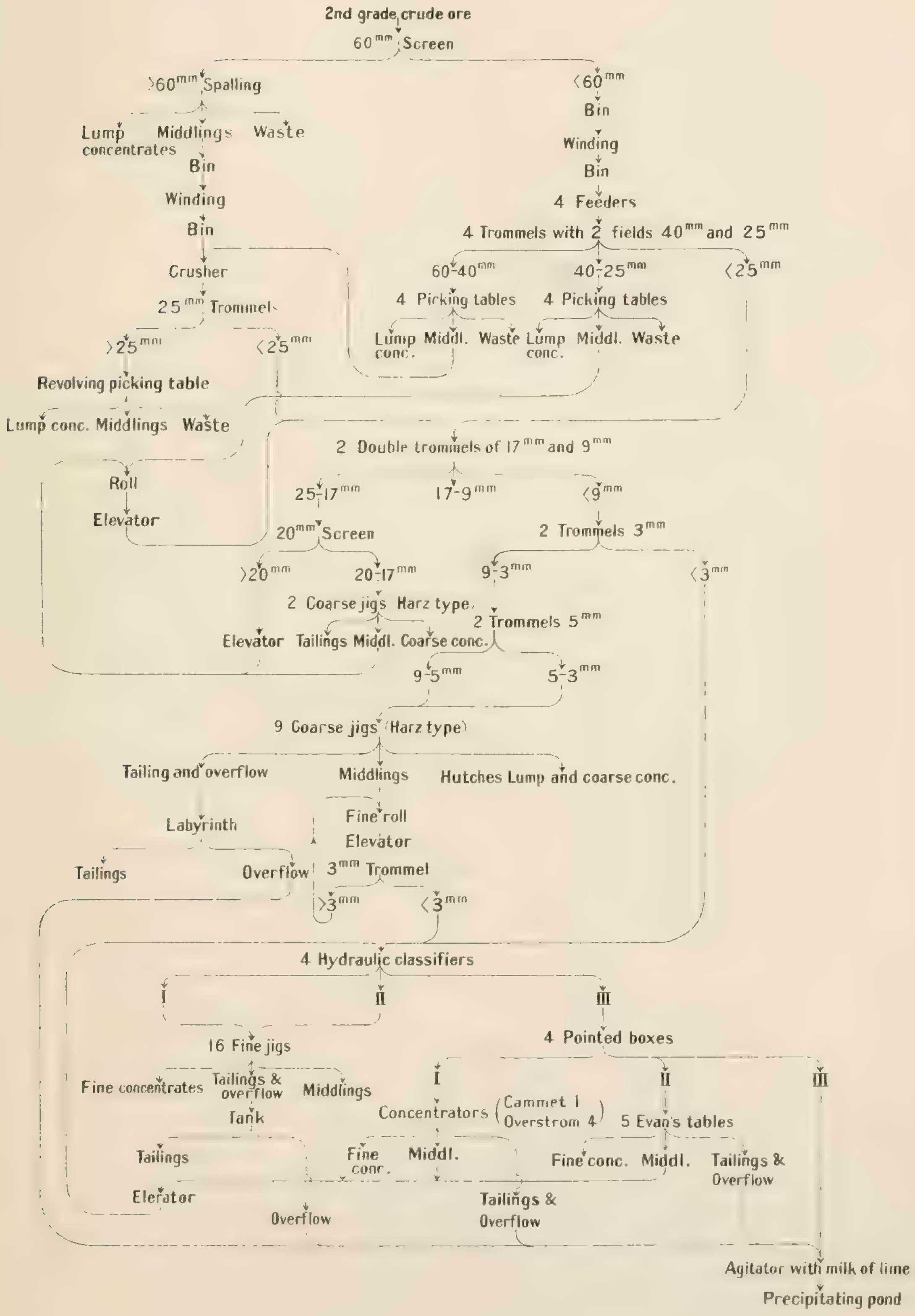
Scheme of Honzan Dressing Plant, Ashio Copper Mines.
(For second grade crude ore)



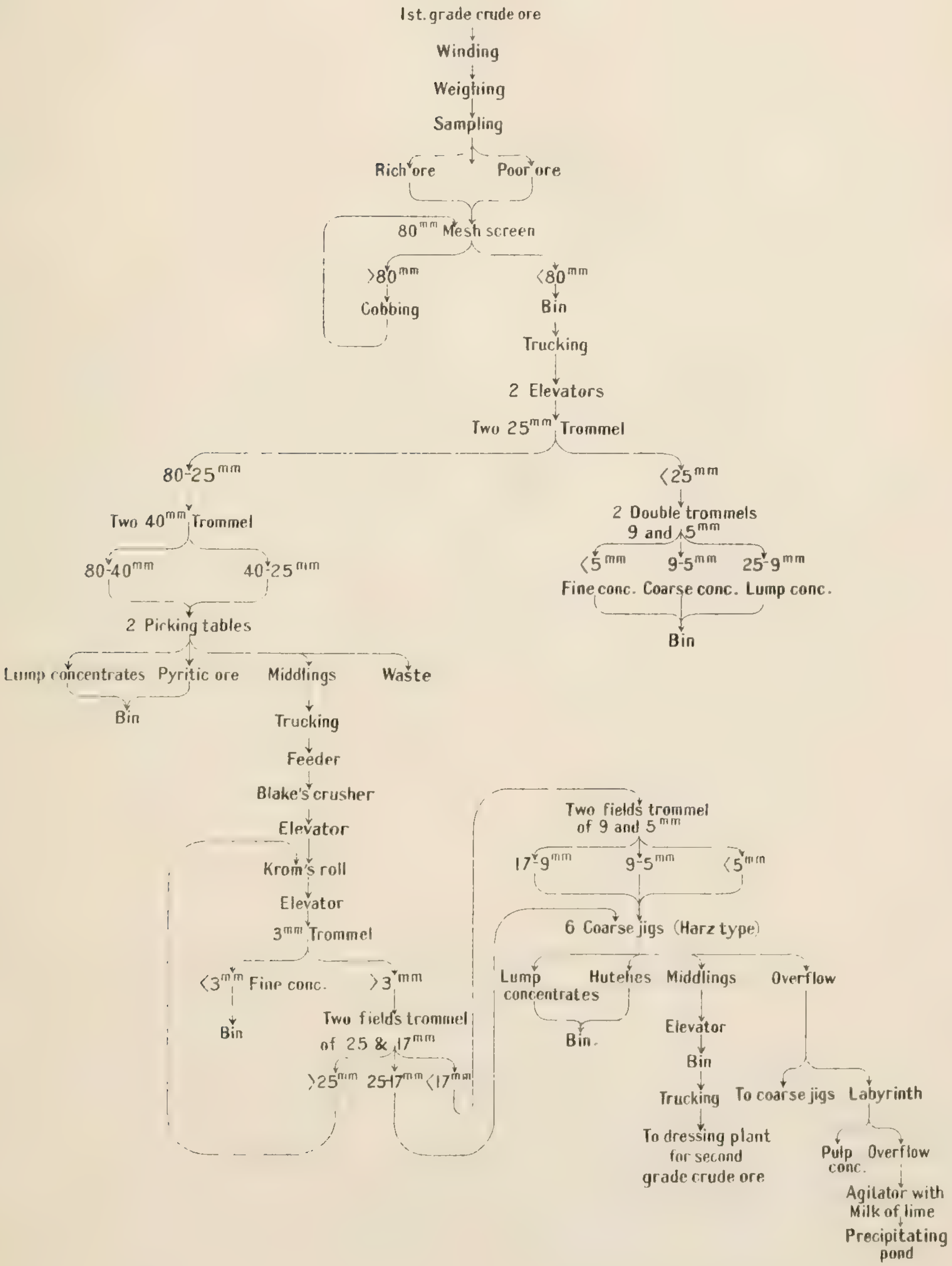
Scheme of Kotaki Dressing Plant, Ashio Copper Mines.
(For first grade crude ore)



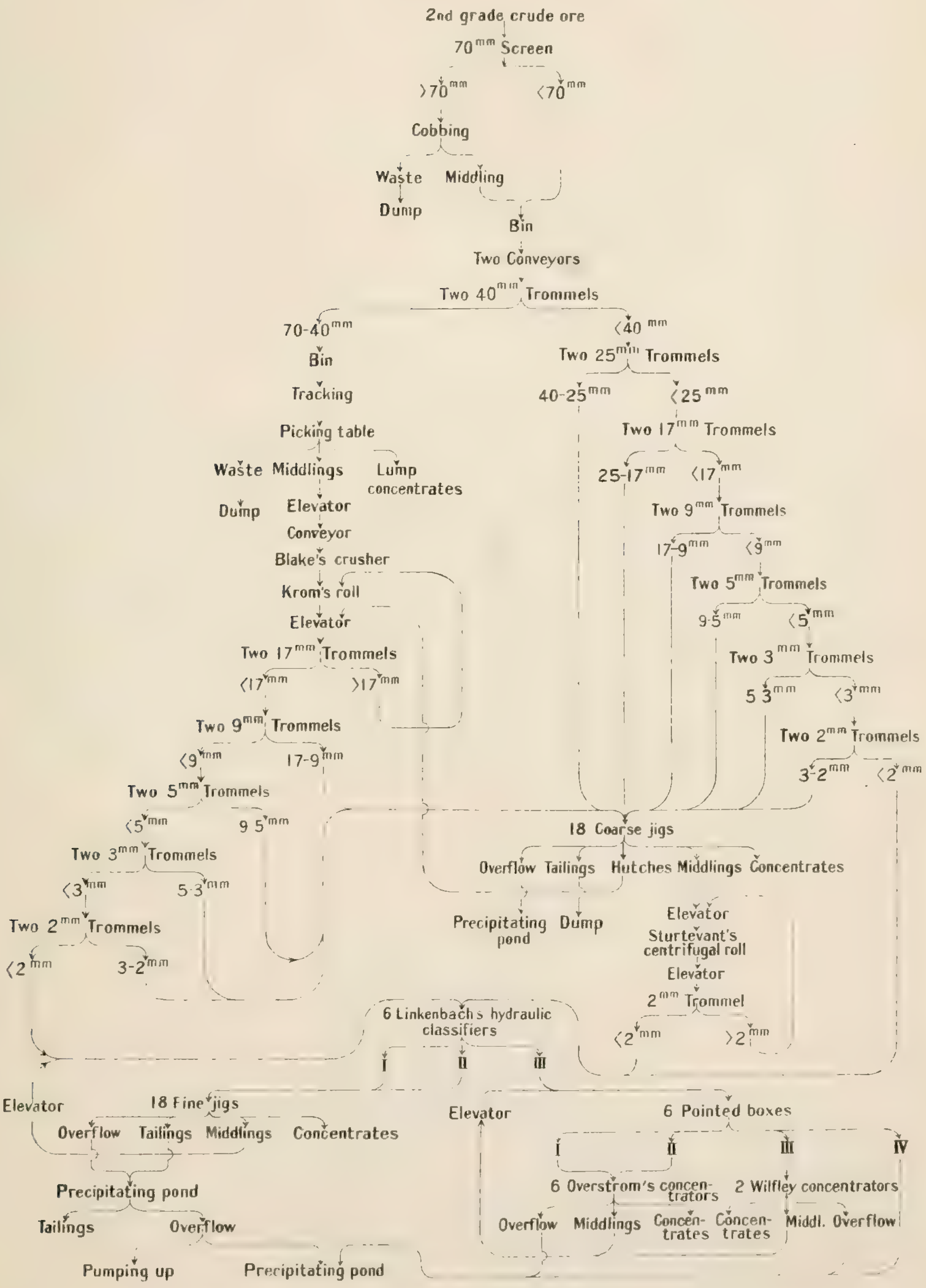
Scheme of Kotaki Dressing Plant, Ashio Copper Mines.
(For second grade crude ore)



Scheme of Tsūdō Dressing Plant, Ashio Copper Mines.
(For first grade crude ore)



Scheme of Tsūdō Dressing Plant, Ashio Copper Mines.
(For second grade crude ore)



Cement Copper.

There are two sources for the winning of cement copper. (1) old workings, abandoned levels, and gob or stope fillings having been exposed for a long time to the oxidizing influence, are the producers of the high grade cupriferous water. (2) the other is the weathered rubbish which has been neglected for years in the dumps. From the waters which leached through them, the copper is precipitated by means of scap iron.

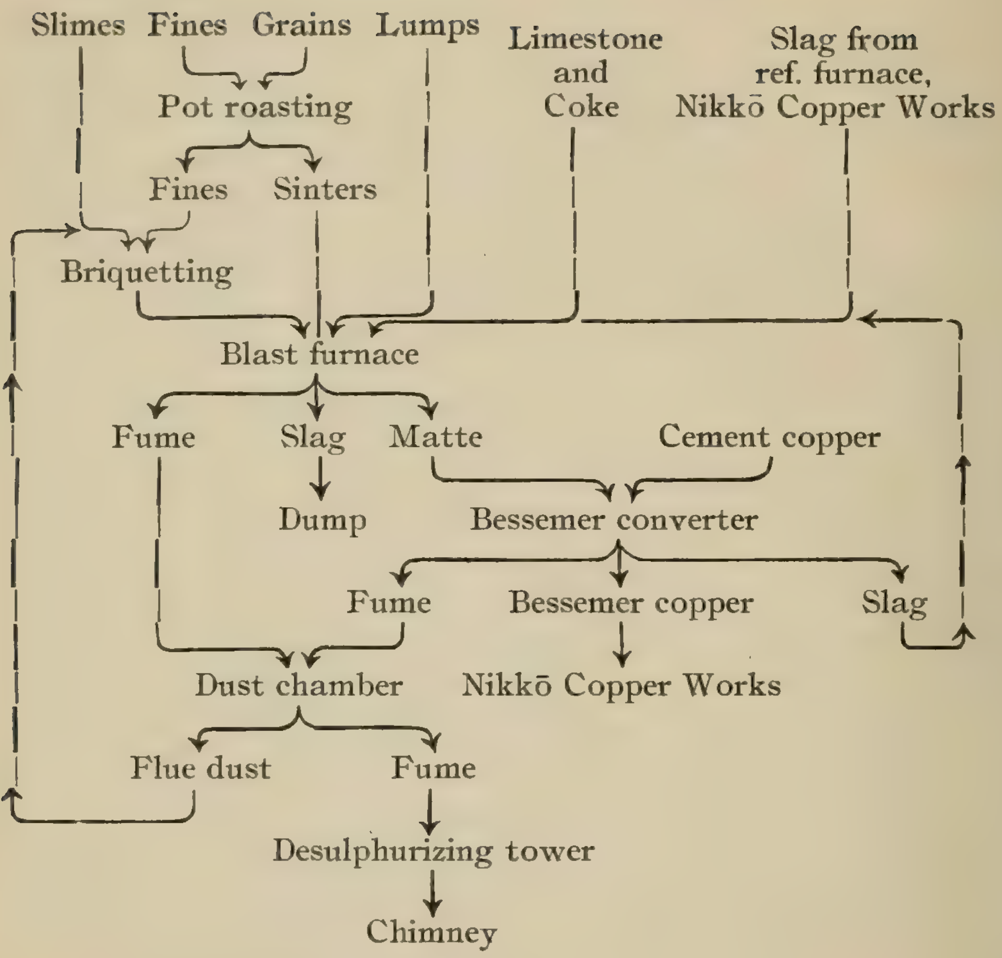
The productionis 1.2 ton of 58% copper a day, which is sent directly to the reduction works.

Reduction.

Ores: The ores consist chiefly of chalcopyrite, pyrite, quartz and a little zincblende and galena. The receiving ores are classified into five: viz. lumps, grains, sands, slimes and cement copper. 60,000 tons of ores on 12% copper are being treated annually, which indicates the production of about 7,000 tons of copper.

Smelting process: The lumps are charged to the blast furnace in a raw state, and the fines in a sintered or a bricked state. The matte thus obtained is subjected to the Bessemer process.

The process will be seen in the following scheme.

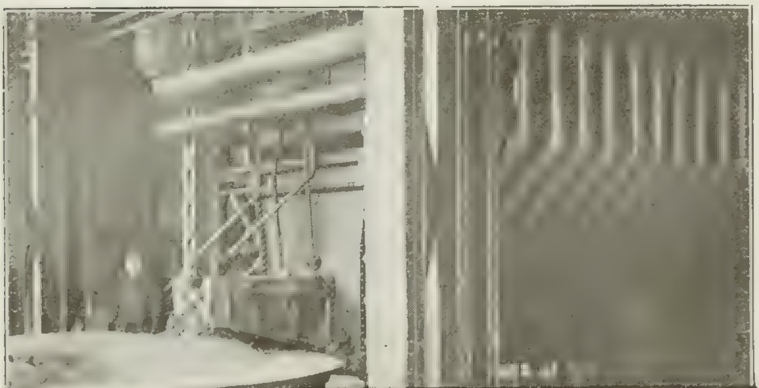


Pot-roasting. Most fines are roasted in pots until they become spongy. The pot used here—of a conical shape—is made of iron plate and has a false bottom which is worth notice, from which the blast is forced in. One charge is about 7 tons of ore. After the sintered mass is cooled thoroughly, it is crushed into suitable size for charging to the blast furnaces. There are twelve pots in two rows, which are used alternately.

Briquetting (patent processes.) There are two processes of briquetting of fine ore for which we hold the patents in America and Japan.

The first :—The ore is first moistened with water and then compressed into a ball of the desired size by machinery. Such a ball is

General View of Reduction Works, Ashio.



Blast Furnaces.

Converters.

placed within the metal mold and the molten matte is then permitted to fill the space within the mold around the ball, and allowed to congeal. A series of the molds are mounted upon an endless carrier which is driven by an electric motor. It is quite interesting to charge the briquets into the blast furnace without the necessity of drying and without the danger of breaking.

The second :—The dried fines and molten matte are allowed to run into the pot, stirring them so that they may be thoroughly mixed together therein. When the mixed mass is chilled sufficiently, it is dumped out of the pot and crushed into suitable size for charging the furnace.

Briquetting (common process). The fines are mixed with slime water, and filled up into the mold, and then stamped into briquets. When they are sufficiently dried up in the drying furnace, they are charged into the blast furnace.

Smelting. The smelting is done by rectangular water jacket blast furnaces. There are three furnaces of the same size. The dimensions of the furnace are 160 inches × 42 inches at the tuyere ; the height from the center of the tuyeres to feed floor, 8 ft. 6 inches ; each furnace has 24 tuyeres whose diameter is 4½ inches, and has one forehearth, 12 ft. in inner diameter, 4 ft. in height. The forehearth is lined with magnesite bricks. For each blast furnace, a Roots blower No. 8 is equipped.

The normal charge composition is as follows :

Lump ore	3,600 lbs.
Sintered ore	3,500 ,,
Briquet	1,100 ,,
Converter slag	1,600 ,,
Limestone	2,200 ,,
Coke	650 ,,

The blast pressure is 1¾ lbs. per sq. inch. The capacity of each furnace is 90 tons for 24 hours. The grade of the matte averages 40% copper ; and the composition of the slag is sillica 40%, ferrous oxide 30%, lime 20%, alumina 9% and copper 0.2%.

Converting. Keeping the matte out of the furnace in the forehearth, we tap it out into a ladle in case of necessity and charge into converter by means of an electric travelling crane, and then the blast is started on. There are six converters, and two stands with hydraulic tilting gears, actuated by a high pressure, self-regulating pump, an accumulator, etc. The converter is of the barrel type, 72 inches in diameter, 100 inches in length, with 11 tuyeres, whose diameter is 1¼ inches. The tuyeres have Dyblie ball valves.

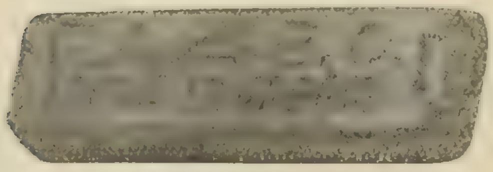
The blast is delivered by two horizontal blowing enginess driven by electricity, capable of supplying 4,200 cub. ft. and 3,000 cub. ft. of free air per minute, and also a vertical one driven by water power, capacity 3,000 cub. ft. per minute. The pressure at the converters is 10 lbs. per sq. inch.

For the purpose of lining, a decomposed liparite is used.

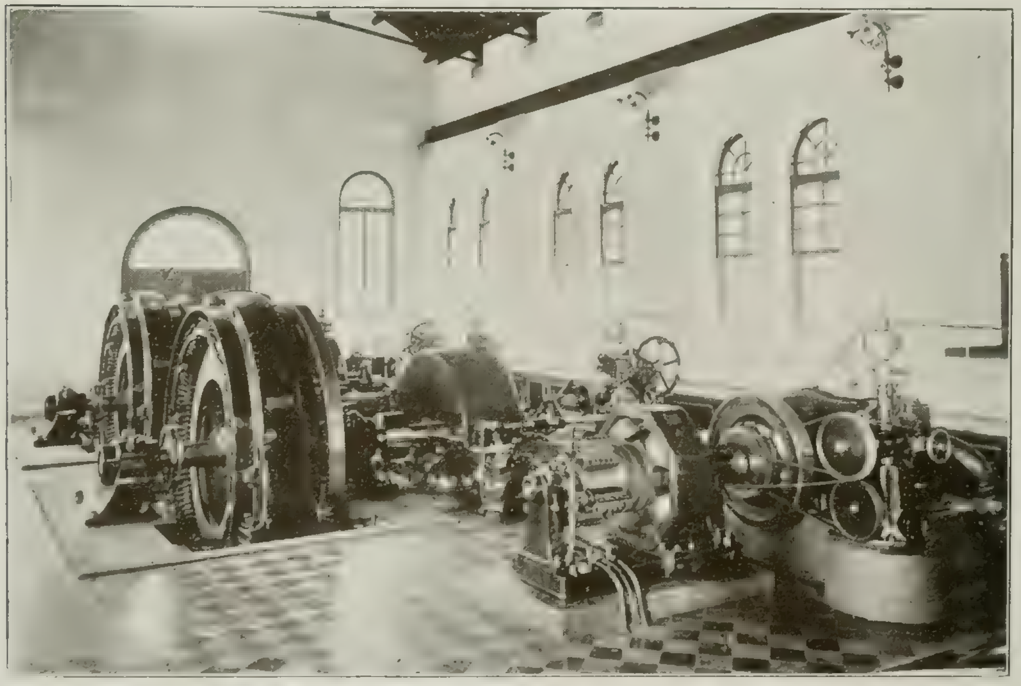
The converters produce 45,000 lbs. of blister copper a day. The blister copper is poured out into molds by casting machines. Each ingot weighes 70 lbs.

Analysis of the blister copper.

Cu	99.125
Au	0.00016
Ag	0.10662
As	0.029
Bi	0.006
Fe	0.052
S	0.028
Se & Te	0.038



Hosoo Power House, Nikkō.



Interior of Hosoo Power House.

Waste Water and Smoke Problem.

The smoke from all the furnaces is forced in to the special dust chamber for condensation. Having precipitated nearly all of the suspended dust in the chamber, the fumes enter the common flue and again proceed to the bottom of the desulphurizing tower, wherein the suphurous acid gas is absorbed by a shower of lime water, and the purified gas escapes through the chimney. The waste water is sent to the precipitating and filtering ponds.

The tail water from the precipitation of cement copper, the slimy water from the dressing plant and the waste water from desulphurizing tower are agitated after being mixed with milk of lime, and are sent to the precipitating and filtering ponds. They are then discharged into the river in the clean and non-acid state.

Power.

The power is chiefly supplied from the Hosoo hyro-electric power plant laid down in 1905, (12 miles from Ashio) developing 2,500 H.P. The power plant is being extended to 7,500 H.P. Besides, we have other small power plants.

The plants are as follows :

Site.	H.P. of Water Wheel.	Generator.	Kw.
Hosoo.	2,500	11,000 volt three phase alternating current.	2,000
,,	125	Direct current.	80
Betsukura.	900	11,000 volt three phase alternating current.	700
Watarase.	250	2,000 volt three phase alternating current.	220
Tsūdō.	400	2,000 volt three phase alternating current.	270
Kotaki.	300	450 volt direct current.	120
,,	100	450 volt direct current.	50

Also there are seven small water power plants which total 500 H.P.

Transportation.

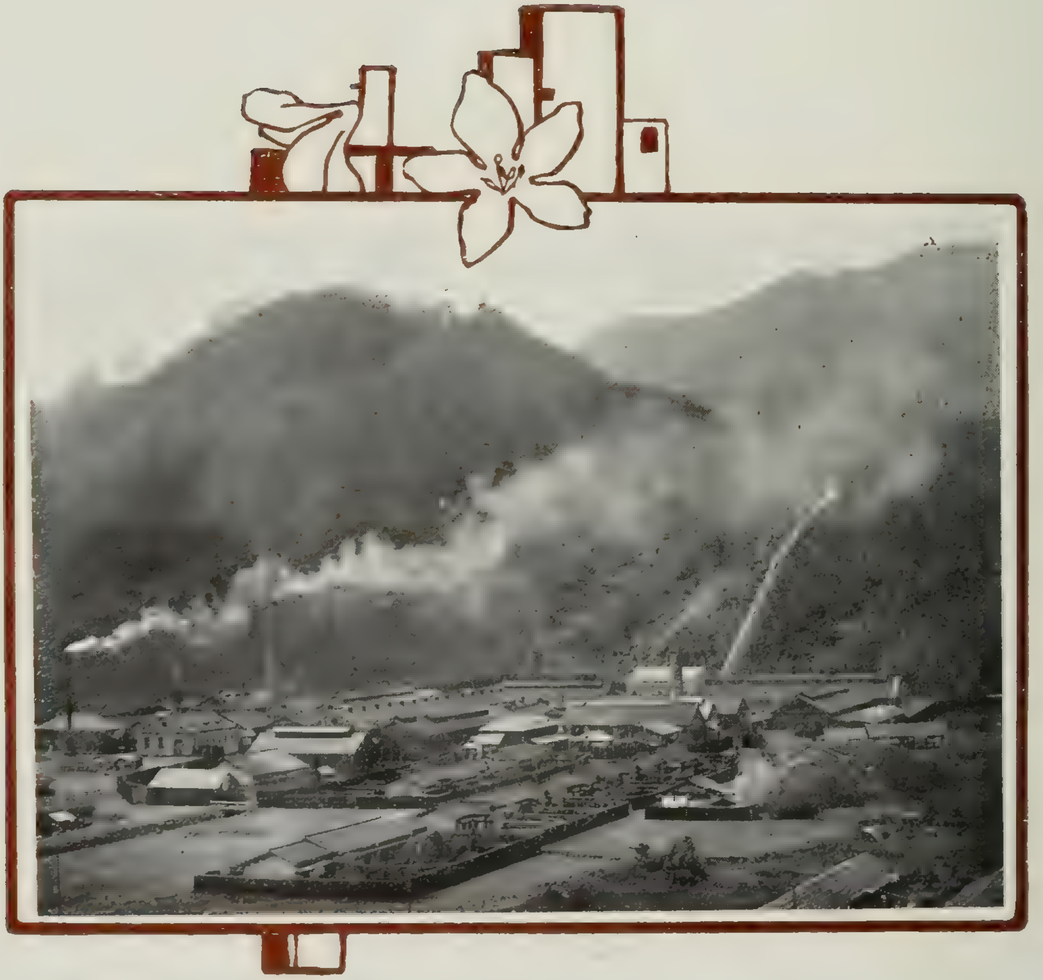
There are two principal transportation lines leading to the mines, viz. the Nikkō line and Ōmama line.

For the Nikkō line, tramways and aerial ropeways are provided now, and the capacity is about 1,300,000 ton-miles a year, this line being mainly used at present. For the principal part of the line, an electric railway has been just completed.

For the Ōmama line, wagons and tramways are used, but they are about to be superseded totally by a railway which is to be built by the Ashio Railway Co. connecting the mines and Kiryu station of the Imperial Government Railway. After the completion, this railway will be the main line of transportation.

Between each mine and reduction works, tramways are used.

For the local transportation of timber, charcoal, limestone etc., Bleihert double ropeway, Tamamura ropeway and Halidie ropeway are used.



General View of Nikkō Copper Works.

Nikkō Copper Works.

The vicinity of Nikkō and Ashio are on the fringe of the median mountain range of Northern Japan. It is very near the Kwantō Plain, and water power can be secured in abundance. Under such conditions, the Nikkō Copper Works were established in 1905 just on the way from the Ashio Copper Mines, so as to afford facilities not only for the taking of the bessemer copper from Ashio, but the transportation of the materials for this works.

The bessemer copper from Ashio and the blister copper from the other mines of the Furukawa Mining Company containing silver and gold, are refined by electrolytic process, and the noble metals separated. The blister copper which does not contain silver and gold is refined in a reverberatory furnace.

The works produce annually 5,000 tons of copper wire, 2,000 tons of copper ingots, 500,000 ozs. of noble bullions etc.

Reverberatory Refining. The bessemer copper and the blister copper, containing silver and gold, are refined and are cast into cakes for rolling to make an anode for the series process.

The blister copper without silver and gold, is refined and cast into ingots which average 99,7% copper. There are four furnaces, two of which have casting machines, and the capacity of each furnace is from 40,000 to 55,000 lbs.

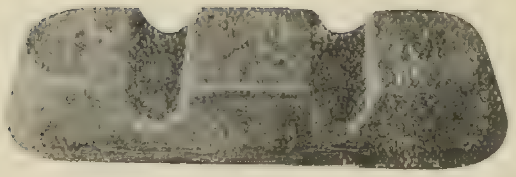
Electrolytic Refining. Here in this works, the series process of electrolytic refining is adopted. The copper cakes are rolled to ¼ inch thick and 12 inches wide. The plates are cut off into pieces of 24 inches long, and are sent to the electrolytic tanks (234 in number).

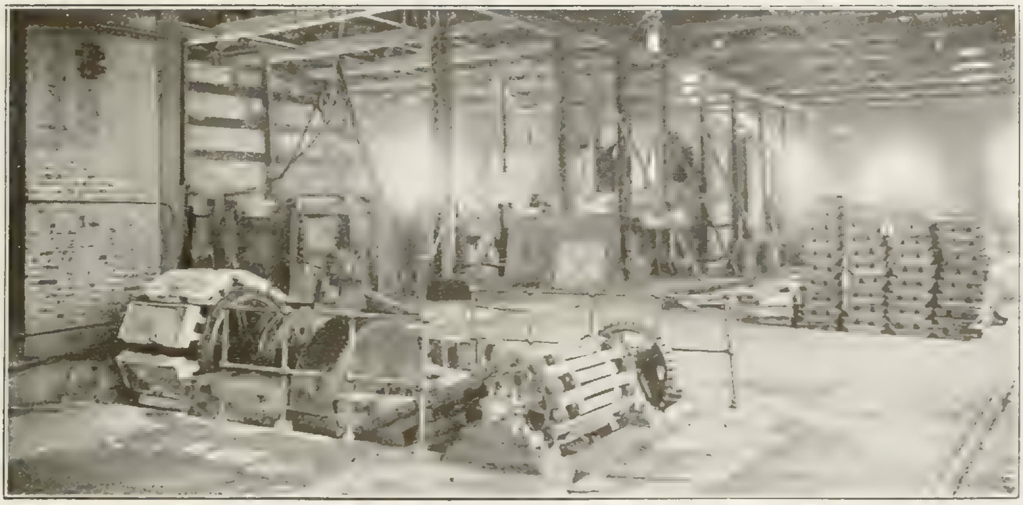
The anode slimes, collected in the tanks, are treated with sulphuric acid, and washed with water, and dried. The dried slimes are refined by English cupellation and cast into noble bullions.

Wire Manufacturing. The electrolytic copper is melted by a reverberatory furnace, and then cast into wire bars. When the wire bars are properly heated, they are subjected to a rolling mill, where several kinds of wire rods are made. These wire rods are drawn into the wire of desired gauge.

There are eight continuous drawing machines and many single drawing blocks. Small wire is also drawn in this works. For annealing the finished wire, we use here the Bates and Peard patent annealing furnace. The hard drawn wire produced here possesses the following mechanical and an electrical properties :

	Tensile strength.	Conductivity.
Wire smaller than 150 mils in diameter.	60,000 lbs. per sq. inch.	98% (Matthiessen's standard.)
Wire larger than 150 mils in diameter.	50,000 lbs. per sq. inch.	98% (,,)





Reverberatory Furnaces.

Tunk Room.

Wire Drawing Room.

Ani Copper Mines.

(Annual production 1,400 tons of copper)

Location.

The Ani Copper Mines are in the town of Ani, on the western part of the Mountain Moriyôshi, in Akitaken.

The area of concession is more than 3,000 acres, and stretches over some 5 miles.

The mines consist of five mines, viz. Kosawa, Kayakusa, Magi, Sammai and Ichinomata, which have ten dressing plants and one reduction works.

History.

The mine Kosawa was discovered in 1670 by a merchant of Ōsaka, and since that time the mines Kayakusa, Magi, Sammai and Ichinomata have been found. In 1702, the whole mines were worked by the Satakes the feudal lords. In 1871, they were transferred to the Imperial Government, and during about ten years they were worked in a large scale under the direction of European engineers. In 1885, they were purchased by the late I. Furukawa.

Geology and Ore Deposit.

The geological formation of Ani Copper Mines is Tertiary sediments, liparite, and andesite. The Tertiary is chiefly an alternation of tuff and tuffaceous shale, and extends over a large area. Its general strike is N–S and the dip is 20°–30° to E or W. The liparite occurs as dyke or mass, and it appears as various facies. The andesite is found also as dyke and it is a kind of pyroxene andesite; sometimes it resembles a diabase.

The ore deposit is veins which traverse the whole formation. The strikes of the veins are of two kinds, the first is N 60° W or E–W, called the E W lode, and the second is N–S or N 30° E, called the N S lode. The dip is usually steep but some of the N S lodes have a low dip, less than 40.° The E W lodes are cut by the N S lodes which are sometimes disrupted veins and occasionally clay veins. The E W lodes are abundant in number, though they are not wide and long generally; and the N S lodes are big but few in number. The E W lodes in the mines Kosawa, Magi and Sammai, and the N S lodes in Kayakusa Mine are usually worked.

The chief metallic minerals are chalcopyrite associated with pyrite. Sometimes, galena and zincblende occur as crystals on the chalcopyrite and pyrite. The vein stuff is quartz mainly, but sometimes calcite and baryte occur also. The oxidized zone extends deeply; and there are bornite, chalcosite, malachite, chrysocolla, native copper etc.

The main lodes are described as follows:

Kosawa Mine.

Machi, Shimoyama-ōdate, No. 1—10 of Meisei, Chōsei-machi, Chosei, No. 8, Banza, Hibira-ōdate, Ōgibira-ōdate, Neumahi etc.

Among them, the last three belong to N S lodes, and the others to E W lodes.

Magi Mine.

Nukanai-ōdate, Atago, Atago-ōdate, Yokohi etc.

The first three belong to E W lodes, and the last to N S lodes.

Sammai Mine.

Irodate, Gonnosuke-okuhi, Kakuchiyama-ōdate, Sanryō-ōdate, Chabakuhi, Neumahi etc.

The last two only belong to N S lodes.

Kayakusa Mine.

Machi, Shimotenguhira-ōdate, Shinsei, Shinsei-uwabanhi, No. 2, No. 3, No. 4, Konsei, Kamitenguhira-ōdate etc.

Nearly all the veins belong to N S lodes.

Ichinomata Mine.

Shōgorohi, Yanagiwarahi, Katsuhira-ōdate, Sasukehi, Ishiganehi, Uwabanhi etc.

Almost of them run with the strike N 50° E.

General View of Ani Copper Mines.

Mining.

Levels and Shafts. There are a good number of levels and shafts, of which a few principal ones will be described as follows.

Kosawa Mine.

Manaita level :—The adit is situated on the bank of the Kayakusa River. The level is driven by crosscutting at first, and then having proceeded along Shimoyama-odate vein and Maehi vein, it penetrates the veine of Meisei, and afterward proceeds along Hibira-odate vein. The level is 10 ft. wide, 7 ft. high and 8,000 ft. long, and double tracks are laid down. It is the most important level for transportation and drainage in Kosawa Mine. Below this level, there are four levels at present.

Kanbun level :—This is situated 130 ft. above the former level, and is driven in a similar way. It is 7 ft. high, 4 ft. wide and 4,500 ft. long. There are some ten levels above the Kanbun level with an interval of 60—80 ft., of which the lower five levels are now in use.

Kosawa main shaft :—The shaft (4 ft. × 14 ft.) is one of the blind shafts, which is sunk at Maehi vein in Manaita level, and it descends for 320 ft. now. Winding and pumping machines are equipped here in the shaft.

Kayakusa Mine.

Chomatsu level :—This is a crosscut which penetrates nearly all of chief veins in this mine. It is 7 ft. high, 10 ft. wide and about 1,000 ft. long, and the most important transportation level. There are seven levels above this level and six levels below.

Sosuido level :—It is the third level below the former, and is 4 ft. wide, 6 ft. high, and 1,700 ft. long. It is used for drainage only.

Kayakusa main shaft :—The shaft (4 ft. × 14 ft.) is one of the blind shafts which is sunk at Shinsei vein in Chomatsu level, and is 500 ft. deep at present. Winding and pumping machines are equipped here.

Magi Mine.

Koganehira levels :—It is the lowest level for the transportation and drainage, and is 7 ft. high, 4 ft. wide, and 1,500 ft. long.

Motosawa level :—It is situated at a height of 50 ft. above the former one, driven chiefly along Atago-ōdate vein, and is 6 ft. high, 4 ft. wide, and 3,000 ft. long. There are ten levels above Koganehira level, and they are connected with winzes.

Sammai Mine.

Amaike tunnel :—The tunnel is cut through at the foot of the mountain range between Kayakusa and Sammai valleys. It is only a road for purpose of transportation and communication. It is the lowest level in the mine and is 7 ft. high, 8 ft. wide and 9,000 ft. long, and double tracks are laid down all the way. During the driving of the tunnel, the chief veins in Kosawa and Sammai were found.

Kaei and Mokichi levels :—The former is opened on the bank of the Kozama River, and being driven along Irodate vein, is the lowest drainage and transportation level. The latter is situated at an elevation of 240 ft. above the former, and cutting through Irodate vein, reaches to Gonnosuke-okuhi vein. Moreover, there are two levels between the Kaei and Mokichi and three levels above the latter. All these levels are connected with winzes.

Ichinomata Mine.

Suidōkō adit :—It is driven by a crosscut at first and then after proceeding along the Shōgorōhi vein, crosscuts several other veins. It is 7 ft. high, 8 ft. wide and 6,600 ft. long, and is the most important transportation and drainage level. There are ten levels above the adit, which are connected with winzes.

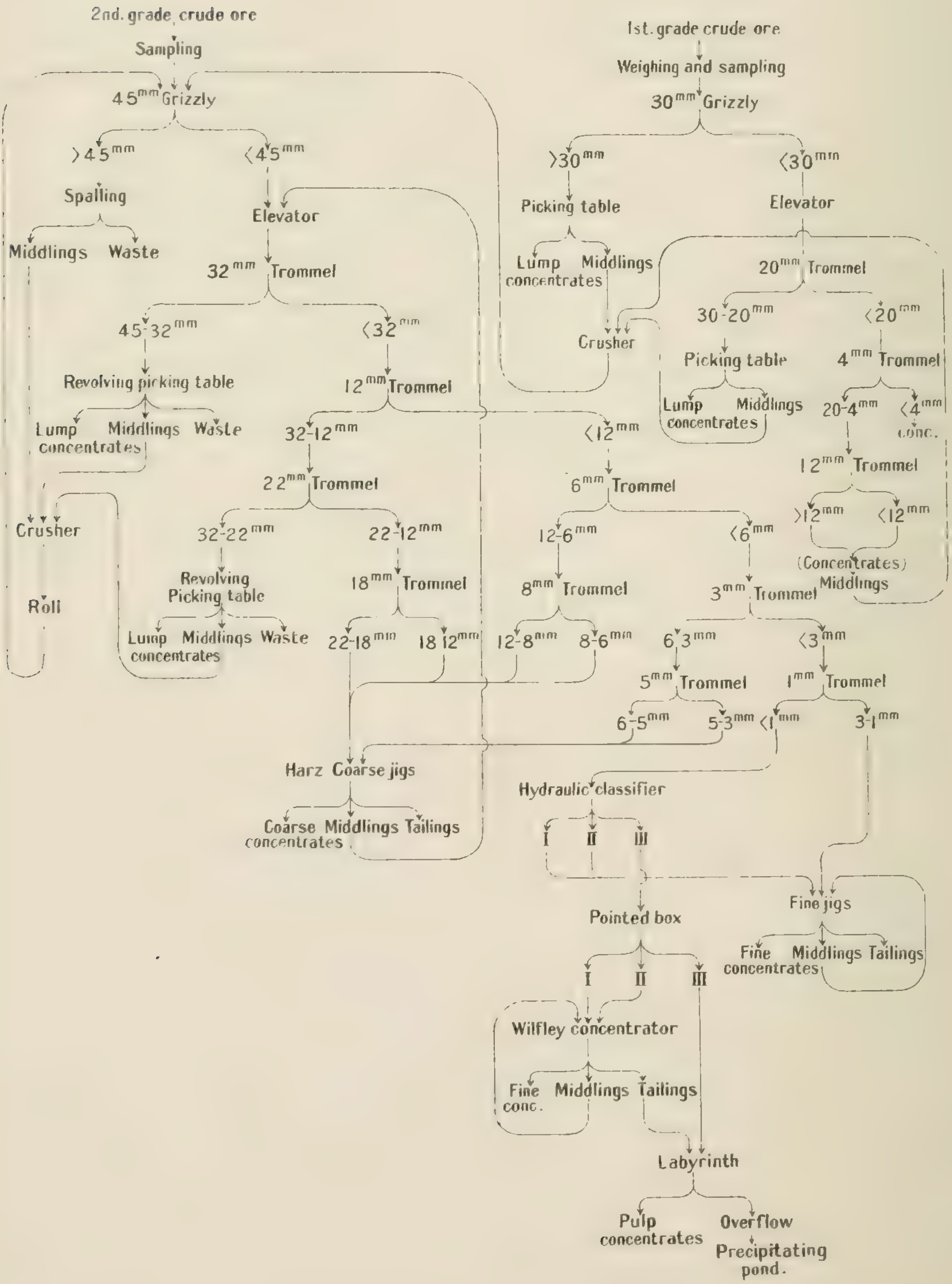
Working method. There are three methods of working, viz. stoping, *Nukibori* (special working for the richer part of vein) and dressed ore contract.

Transportation underground. All levels are equipped with rails. Manaita adit, Chōmatsu level and Amaike tunnel are with a double track horse trolley. In the main shafts of Kosawa and Kayakusa, electric winding machines of 45 H.P. are equipped for the transportation from the lower levels.

Pumping and Drainage. In Kosawa, the water below the Manaita level is pumped up by the following electric pumps :

Knowles sinking pump	5 H.P.	1
Escher-Wyss turbine pump . . .	100 H.P.	2
Knowles triplex sinking pump . .	20 H.P.	2

Scheme of Kosawa Dressing Plant, Ani Copper Mines.



In Kayakusa, the water below the Suidō level is pumped up by the following electric pumps :

Knowles sinking pump	25 H.P.	2
,, ...	20 H.P.	1

Dressing.

Each mine has its dressing plants :
Manaita dressing plant and Naka dressing plant in Kosawa Mine ; Kayakusa dressing plant in Kayakusa Mine ; Koganehira dressing plant, Motosawa dressing plant and Chuōkō dressing plant in Magi Mine ; Amaike dressing plant, Tsunahikizawa dressing plant and Kaei dressing plant in Sammai Mine ; Ichinomata dressing plant in Ichinomata Mine.

Among these, Manaita and Kayakusa dressing plants are equipped with complete dressing machinery which is driven by a Pelton water wheel of 70 H.P. the process is described in the accompanying scheme.

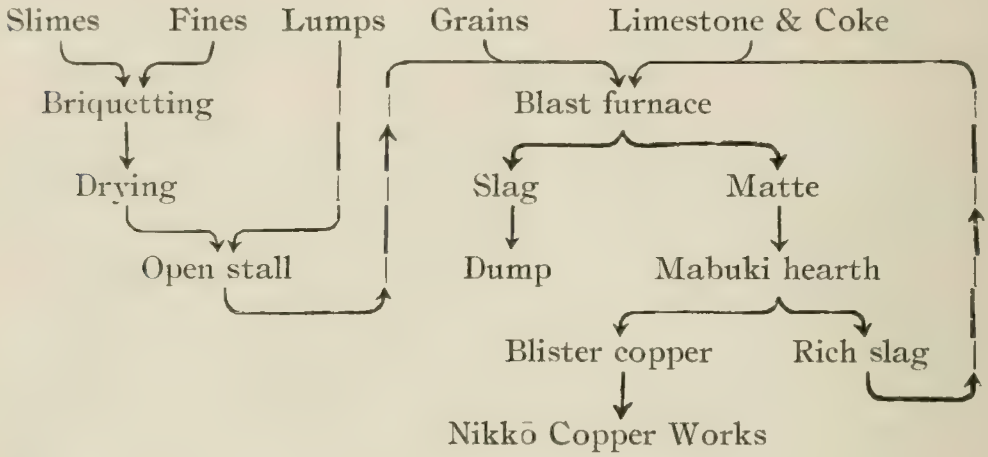
The entire plants treat daily 54 tons of crude ores which carry 4½% copper and produce 38 tons of concentrates of 10% copper.

Each dressing plant has its own precipitating pond in order to settle suspended matter from the waste water. The rich and available parts of the precipitates are sent to the reduction works, the other parts are thrown out into the dump.

Reduction.

Ores : The dressed ores treated here are chiefly chalcopyrite, associated with quartz and iron pyrites at the rate of 40% silica and 10% copper on average. The receiving ores are classified into four, viz. lumps, grains, sands and slimes, of which the first is only 10% of the total quantity of the ores. About 15,000 tons of ore treated annually in the reduction works, which indicates a production of about 1,400 tons of copper.

Smelting process : The fines are first moulded into briquets and after the drying of the briquets is over, they are roasted in open stalls with lump ores. The roasted ores and the grains in a raw state are smelted in blast furnaces with a limestone and *Mabuki* slag, using coke as a fuel. The resulting matte is blown into blister copper by the so-called *Mabuki* process. The scheme shows the reduction process :



Briquetting and Roasting. The materials for briquetting are of the sands and slimes. The materials are mixed with enough water and clay for proper moulding, and are then moulded in cast iron moulds into briquets.

The lumps and the briquets are heaped alternately in open stalls and fired. The dimensions of an open stall are 8 ft. wide 12 ft. long and 6 ft. high and one charge is 55,000 lbs. of ore. The roasting takes three weeks.

Smelting. There are two blast furnaces partly water-jacketed ; one is oval in form, 8 ft. 3 inches × 36 inches at the tuyeres, the other is rectangular, 5 ft. 5 inches × 36 inches at the tuyeres, and the smelting capacity of each is 45 tons and 30 tons in 24 hours respectively. The air blast is delivered by two No. 6 Roots blowers to the blast furnaces and the *Mabuki* hearths. The resulting matte of 40% copper is tapped into a matte-pot and then is charged into the Japanese *Mabuki* hearth.

Mabuki. There are seven *Mabuki* hearths. Each hearth is made in the ground with walls of stone cemented with clay and lined with brasque, and has one tuyere. The dimensions of the hearth are 3 ft. in diameter and 1 ft. 6 inches in depth, and the diameter of the tuyere is 2½ inches. The hearth receives a charge of 7,000 lbs. of molten matte. The molten matte is poured from the matte-pot into the hearth, the blast is started, and the *Mabuki* operation is completed every 24 hours. The blister copper contains 98% copper and 0.11% silver.

The blister copper is sent to the Nikkō Copper Works and refined by an electrolytic method.

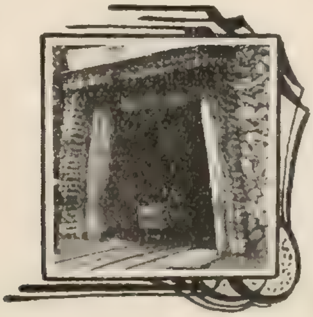
Power.

Hydraulic power of 100 H.P. and hydro-electric power of 400 H.P. are used at present. In a hard winter and dry summer, steam power is used to supplement the lack of water power.

A hydro-electric power plant of 1,000 H.P. is now being erected at Hitachinai.

Transportation.

The communication between all mines and the reduction works is done chiefly by a light railway, and the transportation of goods between the mines and the station Futatsui of the Imperial Government Railway, is carried on by the River Ani for 20 miles, except in winter time when it is done by sleighes.



Furokura Copper Mines.

(Annual production 1,300 tons of copper)

Location.

The Furokura Copper Mines are in the village of Ōyu-mura, in Akitaken. The mines are located on the western slope of the median mountain range in the north are of Japan.

The Area of the concession is abont 2,200 acres. The mines are divided into two, viz. Furokura proper and Hosoji. The reduction works are situated on the opposite side beyond the mountain range.

History.

The Furokura Copper Mines were discovered by Shōemon Tateyama in 1681, but the working was intermittent, and the production insignificant until they came into the hands of the Nambus—the feudal lords. In 1765, the lord attempted to improve the mines, but unfortunately a disaster in the shape of a terrible famine visited the north of Japan in 1784, and at last they were abandoned in 1794. In 1887, the northern part of the mines—Furokura proper—was purchased by the late I. Furukawa, and in 1904 the southern part—Hosoji—came into the possession of the late J. Furukawa. After the amalgamation of both parts, the mines were developed quickly, and the production has been increased to 1,300 tons per year, since the discovery of the large vein called Shijūnenhi, and the future promises well.

Geology and Ore Deposit.

The geological formation of the mines is Tertiary tuff, shale and andesite. The lodes of the mines are the quartz veins which run through all of the rocks. Among them Hompi is the champion lode,

Furokura Copper Mines.

which extends through the mines of Furokura proper and Hosoji. It strikes N 30°—40° E and dips steeply N W or S E. The thickness varies from ¾ ft. to 12 ft., and the length is about 5,000 ft. In the middle part of the vein Hompi, there is a branch called Shijūnenhi whose strike is N 60° W and dip is 60° to S. The Shijūnenhi is being excavated now.

The chief minerals are chalcopyrite and pyrite, and the vein stuff is quartz. Micaceous hematite occurs with the quartz, and sometimes calcite is found in druse. Rarely zincblende and galena occur with the pyrites.

Mining.

Main Levels and Shafts.

Furokura proper.

Ōgiri level :—It is driven along the strike of Hompi, 5 ft. wide, 7 ft. high and about 4,000 ft. long. It is the lowest and most important level for the transportation and drainage in the mine.

Kyūshichi level :—It is situated at an elevation of 260 ft. above the former and is also driven along the Hompi, 4 ft. wide, 7 ft. high and 3,700 ft. long. Besides these there are five levels in the mine, which are connected by several winzes.

Ōgiri and Kyūshichi inclined shafts :—The former shaft (4 ft. × 13 ft.) connects the said two levels, and the latter (4 ft. × 13 ft.) connects the Kyūshichi and the lowest level of Hosoji Mine.

Hosoji Mine.

There are five levels which are driven along the Hompi from the opposite side of the Furokura proper beyond the mountain, of which the 1st. Hosoji level is the lowest on the mine at an elevation of 530 ft. above Ōgiri level of the Furokura proper, and is the most important for transportation and drainage. The interval between levels are from 70 ft. to 80 ft. All the levels are connected with winzes.

Working method. As to the working method, stoping and *Nukibori* are adopted, of which the former is widely used.

Transportation underground. The ores, are taken out from working places to the level on mine cars, and are dumped into the chute. Then they are loaded again on the cars on Ōgiri level, and are transported to the dressing plant by horse drawn cars on rails.

Dressing.

High grade ores are chiefly screened and picked. And low grade ores washed and concentrated.

The scheme explains the dressing operation.

All machinery is driven by a Corliss vertical engine of 70 H.P. and an oil engine of 15 H.P.

The daily output of crude ores from the whole mines is as follows:

1st. grade.	54 tons.	7% copper.
2nd. grade.	60 tons.	1.6% copper.

The concentrates from the plant are 48 tons of 8% copper per day.

The waste water from the dressing plant is sent to precipitating ponds where the tailings settle down, and it is then let into the river.

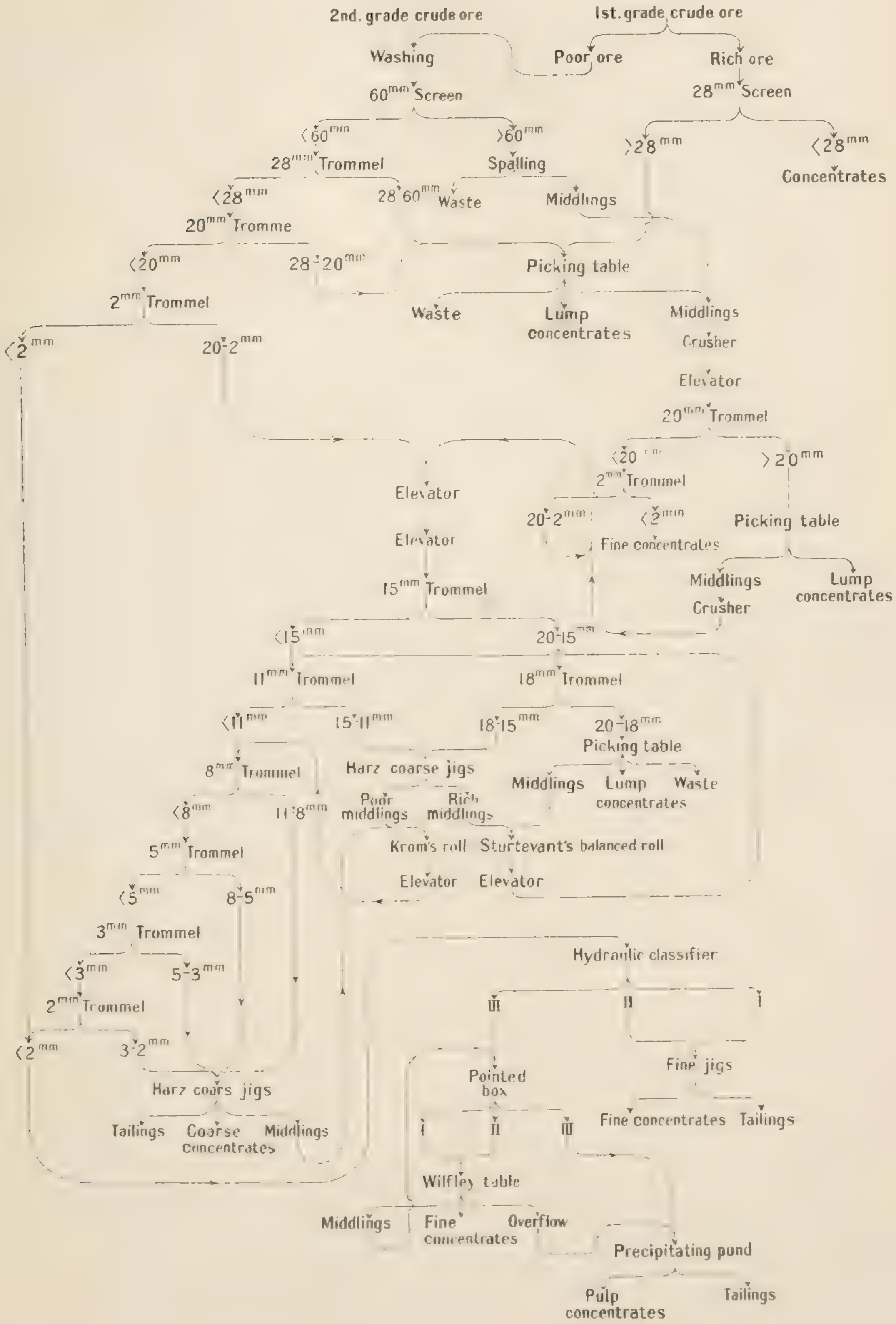
Reduction.

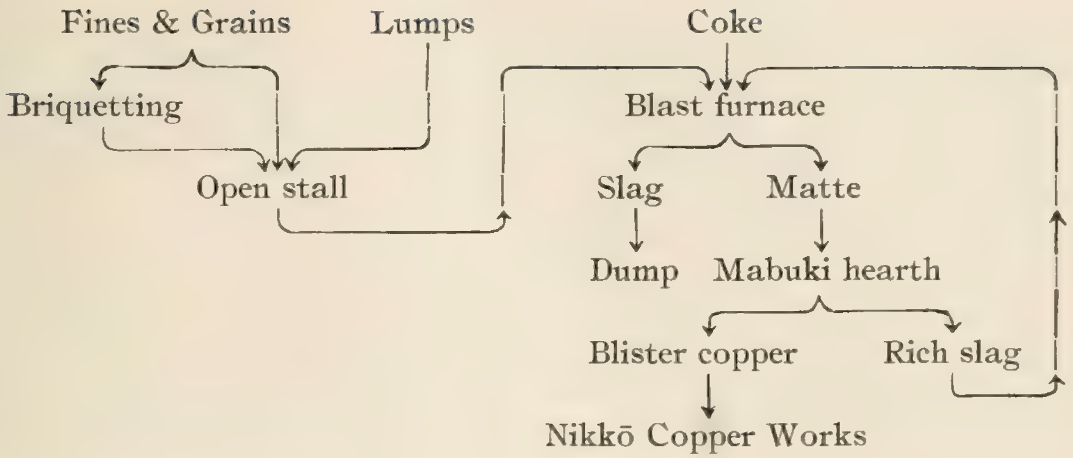
Ores: The dressed ores treated are silicious containing 8% copper on the average. The receiving ores are classified into three, viz. lumps, grains and sands. Some 17,000 tons of ore are treated annually in this works, which indicates the production of about 1,300 tons of copper.

Smelting process: The grains and fines are first briquetted and after the drying is over, they are roasted with the lump ores in open stalls. The roasted ores are smelted in blast furnaces and the resulting matte is blown to blister copper.

The process will be seen in the following scheme.

Scheme of Dressing Plant, Furokura Copper Mines.





Briquetting and Roasting. The grains and sands together with 10—15% of clayey slimes, are moulded into briquets which are dried on heaped ores in open stalls. The lumps and briquets are roasted in open stalls built of slag bricks. The dimensions of the stall are 10 ft. long 7 ft. 6 inches wide and 5 ft. high ; one charge of about 55,000 lbs. or ores, being worked off every three weeks. For firing the ores in stalls, the red hot slag from the blast furnace is used as fuel.

Smelting. The roasted ores are smelted in the rectangular water jacket blast furnaces, 60 inches × 30 inches at the tuyeres, and 8 ft. 6 inches high ; the diameter of the tuyeres is 3½ inches and the number of them is eight.

The charge composition is as follows :—

Roasted lump	500 lbs.
Roasted briquet	500 ,,
Mabuki slag	250 ,,
Slag	50 ,,
Coke	180 ,,

The resulting matte contains 45% copper and the slag carries 0.4% copper on average, and has the composition of bisilicate.

The smelting capacity of each furnace is 30 tons every 24 hours.

The air blast at a pressure of ½ lb. per sq. inch is delivered by a No. 6 Roots blower.

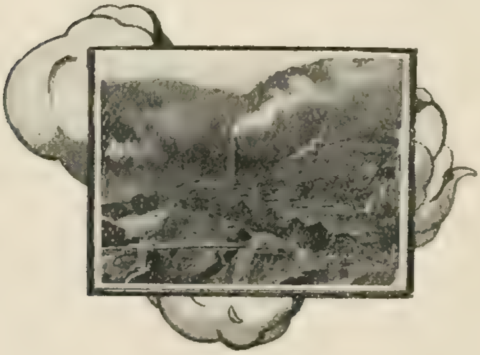
Mabuki. There are six *Mabuki* hearths, which are 32 inches in diameter and 15 inches in depth. One charge is about 6,000 lbs. and the *Mabuki* operation is completed every 24 hours. The resulting blister copper has 98.5% copper and a trace of silver. The blister copper is sent to the Nikkō Copper Works and refined.

Power.

A 70 H.P. vertical Corliss engine, and 20 H.P. and 15 H.P. oil engines are equipped to drive the dressing machinery; and a 40 H.P. Pelton water wheele is provided to drive the blower for the furnaces.

Transportation.

The transportation between the mines and Sannohe station of the Imperial Government Railway is carried on by wagon for 22 miles.



Mizusawa Copper Mines.

(Annual production 350 tons of copper)

Location.

The Mizusawa Copper Mines are in the village of Iwasaki-mura, in Iwateken. The area of concession is about 1,000 acres.

History.

The mines were discovered in 1717, and were opened in 1737, but the working was intermittend. In 1891, they were purchased by the late I. Furukawa and have been enlarged to the present state.

Geology and Ore Deposit.

The district of the mines is composed of granite, Tertiary tuff and liparite which is intruded into the Tertiary. The ore deposit is veins. Maehi, Okuhi, and Uwabanhi are the biggest lodes, and they run mainly in the granite on the strike N 60° E. The Maehi is now working, and it averages 3 ft. thick and 2,000 ft. long.

The chief metallic minerals are chalcopyrite and pyrite, and sometimes galena and zincblende are found in small quantity. The vein stuff is quartz but not abundant. Calcite occurs in druse.

Mining.

Levels. There are many levels, of which the chief ones are as follows:

Tsūdō adit level:—It is the lowest level and is used for transportation and drainage with a length of 500 ft.

No. 6 level:—It is the main transportation level, and its total width is about 1,400 ft.

Working method. Stoping is chiefly adopted.

Dressing.

It is chiefly done by mechanical concentration. All the machinery is driven by a steam engine and Pelton water wheel.

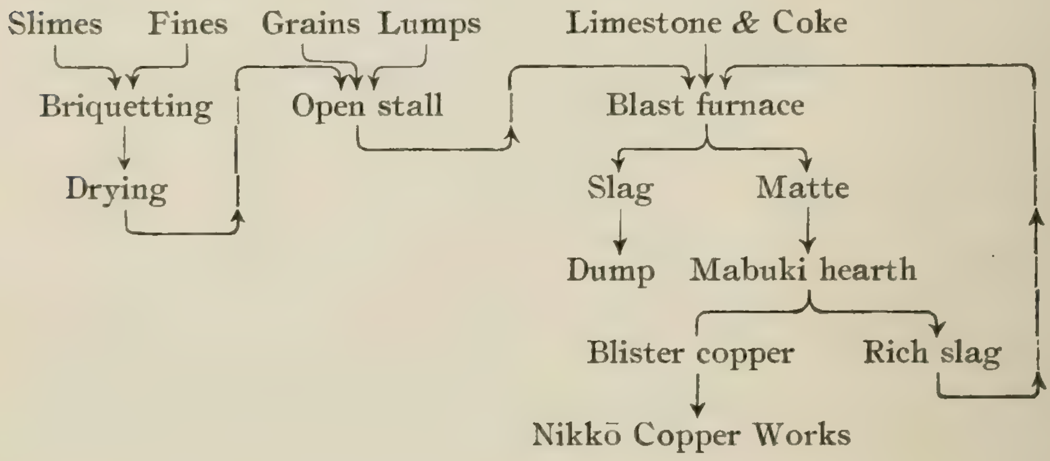
The crude ores are 70 tons of 2% copper and the concentrates are 9 tons of 10% copper a day.

The operation will be described in the accompanying scheme.

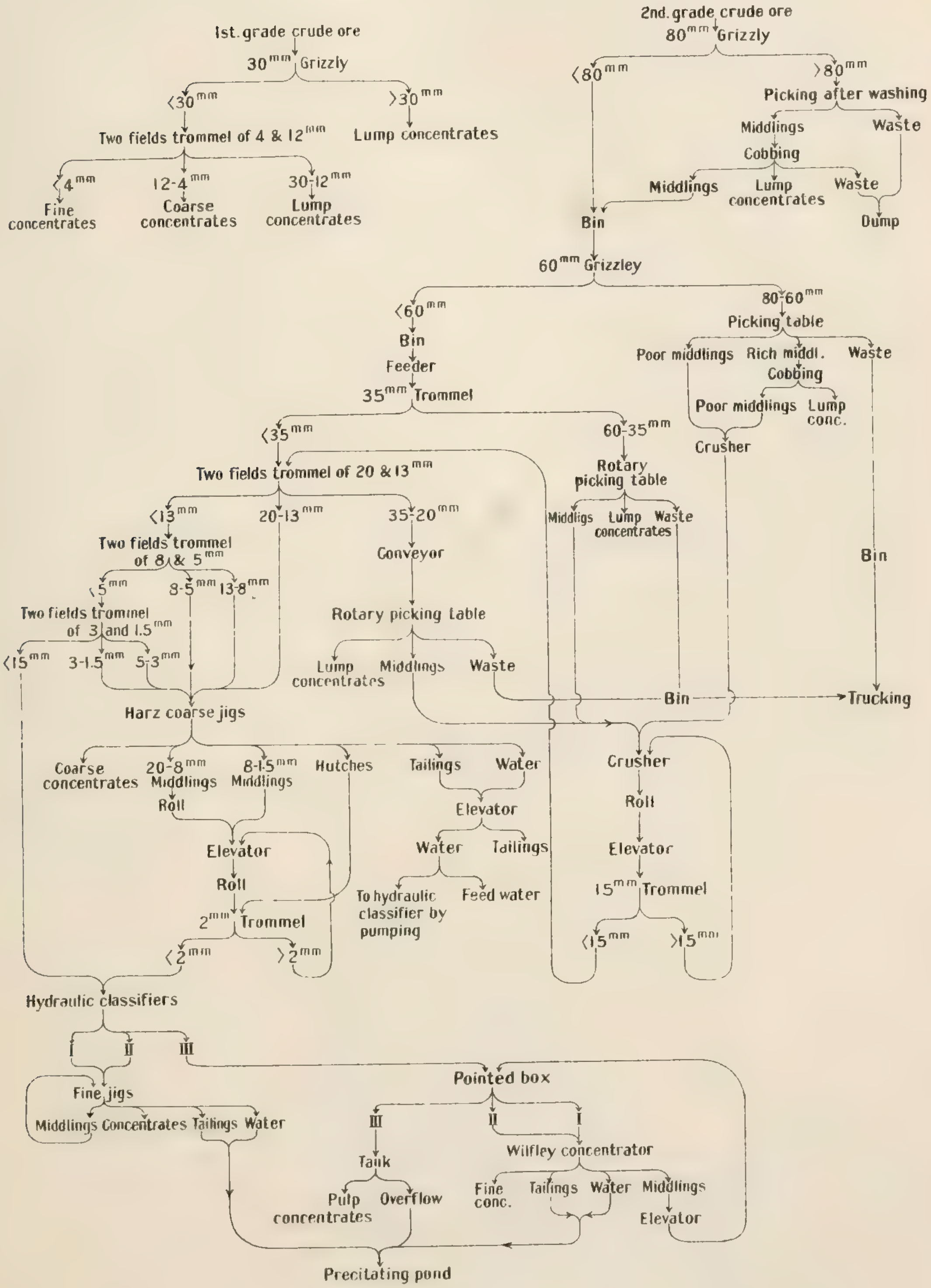
Reduction.

Ores: The dressed ores are siliceous, containing 10% copper on the average. The receiving ores are classified into four, viz. lumps, grains, sands and slimes; and about 3,200 tons of ore are treated annually, which indicates an annual production of about 350 tons of copper.

Smelting process: The sands, slimes and grains, are made into briquets. After drying, the briquets are roasted in open stalls with lumps. The roasted materials are smelted in the blast furnace, and the resulting matte is blown to blister copper by Japanese *Mabuki* process. The process will be described in the accompanying scheme.



Scheme of Dressing Plant, Mizusawa Copper Mines.



Briquetting and Roasting. The grains, sands and slimes are mixed with water to a consistency suitable for proper moulding. The mixtures are briquetted in cast iron moulds, and the briquets are dried on the roasting heaps of ores in the stalls.

The dried briquets and lumps are roasted in open stalls, made of slag bricks.

Smelting. The blast furnace is a rectangular water jacketed one, 33 inches × 66 inches at the tuyeres and 10 ft. 6 inches high; the diameter of the tuyeres is 2½ inches and the number of them is eight.

The charge composition is as follows:

Roasted ore	750 lbs.
Mabuki slag	160 ,,
Old slag	500 ,,
Raw matte	120 ,,
Limestone	300 ,,
Charcoal	100 ,,
Coke	130 ,,

The smelting capacity every 24 hours is about 15 tons of the ores and 10 tons of old slag. The resulting matte contains 40% copper on the average. The air blast at a pressure of ½ lb. per sq. inch is delivered by a blower of the No. 5 Roots type.

Mabuki. The *Mabuki* hearth treats 6,000 lbs. of matte, and converts the matte into blister copper in 20—24 hours. The blister copper contains 98.5% copper and a trace of silver, and is sent to Nikkō Copper Works.

Kusakura Copper Mines.

(Annual production 300 tons of copper)

Location.

The Kusakura Copper Mines are in the village of Ryōganose-mura, in Niigataken, where it is located in the middle of the River Aga.

The Area of the concession is about 600 acres.

History.

In 1739 the mines were discovered by a villager of Tsugawa, but they were not worked properly until the time the late I. Furukawa purchased them in 1876. These were the first mines to come into the hand of the Furukawa family, and for them the purchaser introduced modern methods and enlarged the capacity.

Geology and Ore Deposit.

The district consists of Tertiary sandstone, shale and tuff, also liparite as well as andesite, and the latter two occur as dykes and sheets. The ore deposit is veins. They run through all of the rocks, and the ore contents varies according to the nature of the rocks; that is, the contents are the richest in sandstone and the poorest in shale and tuff. The constituent of the veins is chalcopyrite only as usual, and sometimes pyrite occurs with it but not in abundance. Earthy hematite is frequently found in small quantity, and zincblende as well as galena very rarely. In the oxidized zone, chalcocite, cuprite, and native copper are found commonly. The vein stuff is quartz very small in quantity.

There are 3 chief lodes in the mines, viz. Kusakurahi, Funauchizawahi and Nameradakihi. All of them run N 30° W and dip 80° SW.

General View of Kusakura Copper Mines.

Reduction Works.

Their thickness varies from 2 inches to 6 ft., averaging one foot. The veins have generally numerous branches. The length of Kusakurahi and Funauchizawahi is 2,500 ft. and that of Nameradakihi 1,000 ft.

Mining.

There are many levels on the mines, of which the principal ones are as follows.

Ōkawamae adit level: The level is driven chiefly along the veins of Nameradaki, Funauchizawahi and Kusakurahi. It is used mainly for drainage, and its total length is 10,000 ft.

Sanjindō level:— It is driven chiefly along the veins of Funauchizawahi and Kusakurahi at a height of 480 ft. above the former. It is used for drainage and transportation.

Tsūdō level:— It is situated at a height of 700 ft. above Ōkawamae adit level and is driven 2,500 ft. long along Kusakurahi after having proceeded 1,200 ft. by crosscutting.

Honkuchi level:— It is situated at a height of 1,000 ft above Ōkawamae level. It is driven 2,000 ft. along Kusakurahi, and is used only as a passage for the miners.

Dressing.

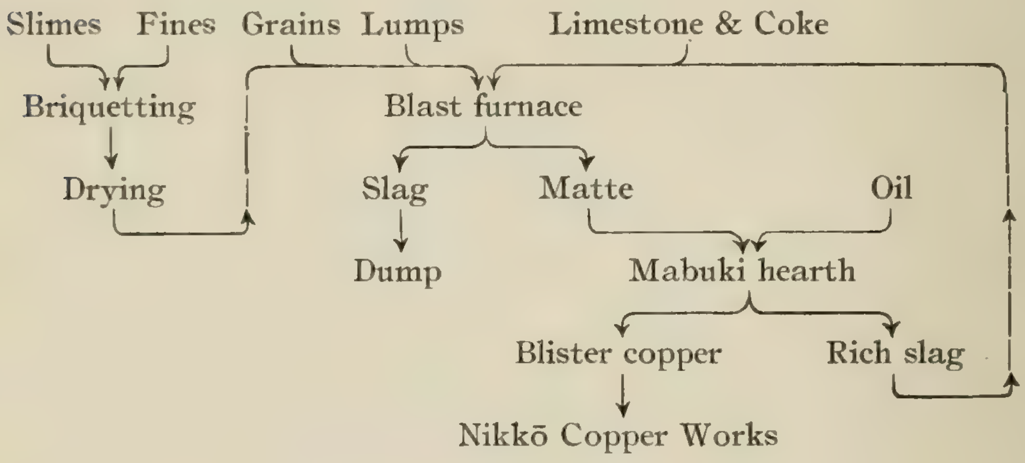
The dressing is done by hand sorting and mechanical concentration. The machinery is driven by a Pelton water wheel. The crude ore treated a day is 36 tons of 2.6% copper, and concentrates 7 tons of 12,5% copper.

Reduction.

Ores: The dressed ores treated here are silicious and contain 12.5% copper on the average. The receiving ores are classified into four, viz. lumps, grains, sands and slimes. About 2,500 tons of the dressed ores are treated annually in the reduction works, which would indicate the production of *circa* 300 tons of copper.

Smelting process: The sands and slimes are first made into briquets. The lumps, grains and briquets, in raw state, are smelted in the blast furnaces to the matte which is blown to blister copper by *Mabuki* process.

The process will be seen in the following scheme:



There are two blast furnaces of 5 ft. × 30 inches at the tuyeres and 8 ft. high and the number of tuyeres is twelve of 3 inches diameter. The charge composition is shown here under.

Raw ores	667 lbs.
Mabuki slag	167 ,,
Slag	125 ,,
Limestone	300 ,,
Coke	110 ,,

The smelting capacity of each furnace is 42,000 lbs. every 24 hours. The resulting matte averages 40% copper. The blast is furnished by a No. 4 Roots blower driven by steam power, generated by oil fuel.

There are three Japanese *Mabuki* hearths of 3 ft. in diameter and of 1 ft. 4 inches in depth. Each hearth has one tuyere 2½ inches in diameter. The molten matte from the forehearth of the blast furnace is tapped directly into the *Mabuki* hearth and the blast with oil spray is started, heavy oil being used. This is the first place where oil was ever used in Japan as liquid fuel for the metallurgical process. The capacity of each *Mabuki* hearth is 2,000 lb. of blister copper every 24 hours. The blister copper contains 98.5% copper and 0.02% silver, and sent to Nikkō Copper Works.

Transportation.

The transportation between the mines and the city of Niigata is carried on boats on the River Aga at present, but a railway is now being erected from Niizu near the city of Niigata.

Nagamatsu Copper Mines.

(Annual production 300 tons of copper)

Location.

The Nagamatsu Copper Mines extend over the village of Ōkuramura and the town of Shiraiwa-machi, in Yamagataken, where they are situated on the south of Mount Gassan.

The Area of the concession is *circa* 1,000 acres.

History.

The exact date of discovery of the mines is unknown, but it is said that in the latter half of the seventeenth century, Kichiemon Izumiya an ancestor of the Sumitomos of Ōsaka, the owner of Besshi Copper Mines, possessed the mines. After passing through various hands, they were purchased by the late I. Furukawa.

Geology and Ore Deposit.

The district of Nagamatsu Copper Mines consists of an alternation of Tertiary shale, tuff and sandstone with extensive intrusives of liparite and andesite. The ore deposit is clay veins which run through all of the rocks, and consists chiefly of chalcopyrite and pyrite ; sometimes zincblende and galena are found but not commonly. The vein stuff is quartz but very little. Baryte occurs occasionally.

Mining.

There are many levels, of which Ōgiri and Chūgiri levels are the most important. The former is the lowest and 6 ft. wide, 8 ft. high

Reduction Works of Nagamatsu Copper Mines.

and 5,000 ft. long, and the latter is 380 ft. above the former and is 4 ft. wide, 6 ft. high and 2,500 ft. long.

For the working method, the *Nukibori* is generally adopted.

Dressing.

The dressing is chiefly done by hand sorting and mechanical crushing. Crushers and stamps are operated by a water wheel of 10 H.P. Crude ore is treated to the amount of 31 tons of 3.6% copper, and concentrates 7 tons of 12.4% copper a day.

Reduction.

Ores: The dressed ores average 11% copper and are easily fusible. The receiving ores are classified into four, viz. lumps, grains, sands and slimes. About 2,700 tons of ores are treated annually in the works, which indicates the production of about 300 tons of copper.

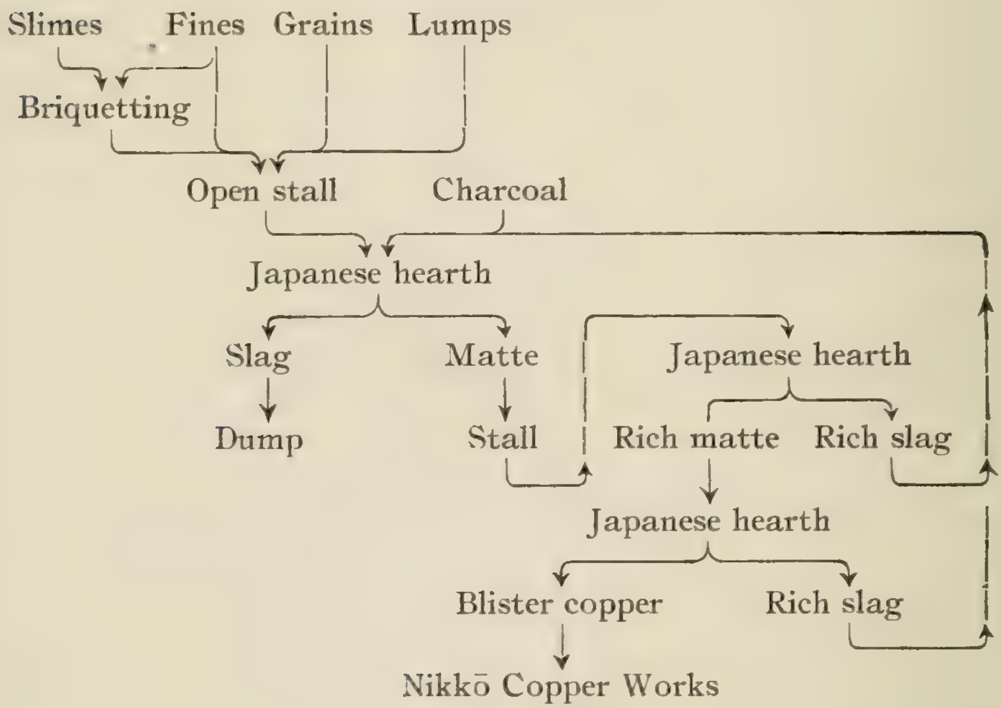
Smelting process: The grains, sands and slimes are first made into briquets. The lumps and briquets are roasted in open stalls. The roasted materials are smelted to matte in Japanese smelting hearth. The matte is then blown to blister copper in the same hearth.

Briquetting and Roasting. The grains, sands and slimes are mixed with water to a consistency suitable for proper moulding, filled into the mould of cast iron, and tampped by hammer. The briquet is then taken out and dried by the waste heat of the stalls. After drying of the briquets is over, the briquets and lumps are heaped alternately in open stalls, and are roasted for 20 days.

Smelting and Mabuki. The Japanese smelting hearth is made in the ground with walls of stone cemented with clay, and lined with brasque. The hearth treats 5,000 lbs. of the roasted ores together with 1,500 lbs. of charcoal every charge. The smelting is finished in 10 hours. The slag is then raked out and the matte thus formed is cooled off by water sprinkled on the surface, and is stripped off into thin sheets. The matte thus produced contains 35% copper and is roasted in stalls and then it is smelted again to the concentrated matte containing 60% copper in the similar hearth. The concentrated matte is again roasted in stalls and smelted to blister copper in *Mabuki* hearth. The blister copper contains 97% copper and 0.18% silver; and is sent to Nikkō Copper Works.

The blast is delivered by a No. 4 Roots blower.

The following scheme shows the process of reduction.



Ōtori Copper Mines.

(Annual production 180 tons of copper)

Location.

The Ōtori Copper Mines are located in the village of Ōizumi-mura, in Yamagataken.

The area of the concession is 100 acres.

History.

The date of opening of the mines is uncertain. In 1895, they came into the possession of the late I. Furukawa.

Geology and Ore Deposit.

The ore deposit of the Ōtori Copper Mines is the veins which traverse Tertiary agglomeratic tuff and liparite. Hompi is the chief lode, which strikes E—W, and dips 80° to N. It is 1—6 ft. wide and 2,500 ft. long. The metallic minerals of the vein are chalcopyrite and pyrite and the vein-stuffs are quartz and rhodochrosite, both very small in quantity.

Mining.

There are several levels, of which the principal ones are as follows: Tsūdō level is the lowest one and it is 4 ft. wide, 6 ft. high and 1,600 ft. long. Ōgiri level is situated 420 ft. above the former, being 4 ft. wide, 6 ft. high and 1,200 ft. long.

As to the working method, *Nukibori* and stoping are adopted here in the mines.

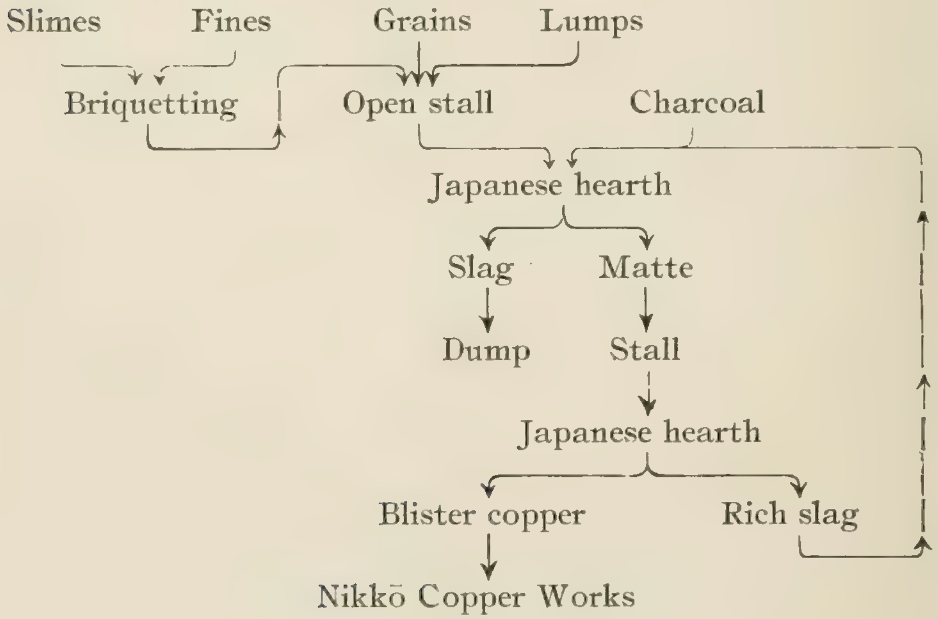
Dressing.

The dressing is done by hand crushing and sorting. Crude ore is treated to the quantity 12 tons of 5% copper and concentrates 5 tons of 11% copper a day.

Reduction.

The ores are silicious with the bulk of impurities such as tin, arsenic, antimony, bismuth etc. and averaging 11% copper. The receiving ores are classified into four, viz. lumps, grains, sands and slimes. About 1,800 tons of ore are treated annually in this reduction works, which indicates the production of about 180 tons of copper.

The smelting process will be described in the following scheme.



Briquetting and Roasting. The sands and slimes are mixed to a stiff mud moulded in cast iron moulds. After drying the briquets, they are roasted in open stalls mixed with the lumps and grains.

Smelting. The roasted ores are smelted to matte by Japanese smelting hearth, with charcoal as fuel. The matte is roasted in stalls and is smelted again to blister copper. The blister copper contains 96.5% copper and 0.22% silver, which is refined electralytically in the Nikkō Copper Works.

Kune Copper Mines.

(Annual production 67,000 tons of ore)

Location.

The Kune Copper Mines are in the village of Sakuma-mura, in Shizuokaken, and are situated in the middle of the River Tenryū.

The area of the concession is more than 3,000 acres.

The mines have no dressing plant and no reduction works, the pyritic ores being sold to market.

History.

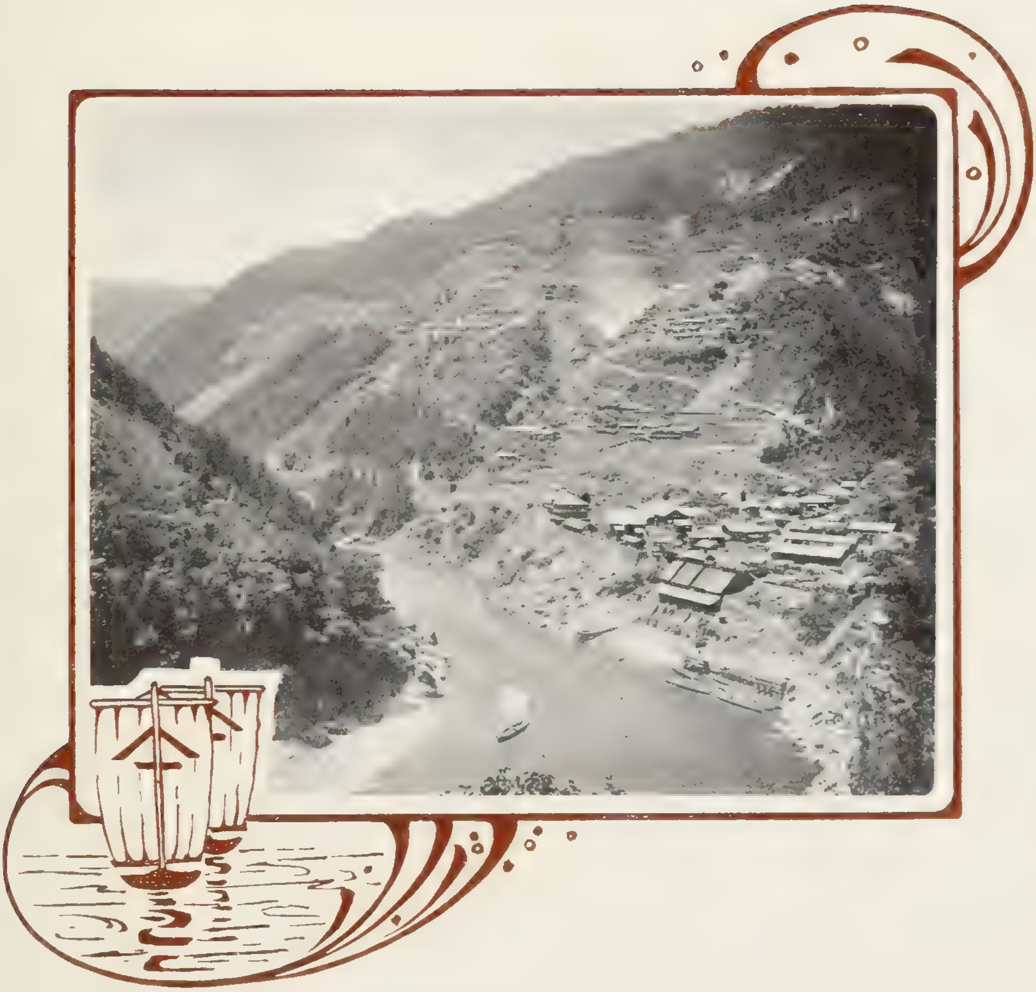
The date of the discovery of these mines is obscure, but the opening was in 1731, and since that time they have been idle. In 1892, H. Hara discovered the largest ore body. In the year of 1897, they were purchased by the late I. Fnrukawa who devoted himself to the development of the mines, and he proved the existence of a wonderfully big ore body. Then the mines suddenly became important in Japan. Ever since then active operations have resulted in the greatly increased production. The mines continue with the development of the now famous ore body as well as other ones.

Geology and Ore Deposit.

The geological formation of the mines is the crystalline schist of Sambagawan series which will be probably the Argonkian.

The crystalline schist consists of graphite schist and chlorite schist which strike N 35° E and dip 30—60° N W.

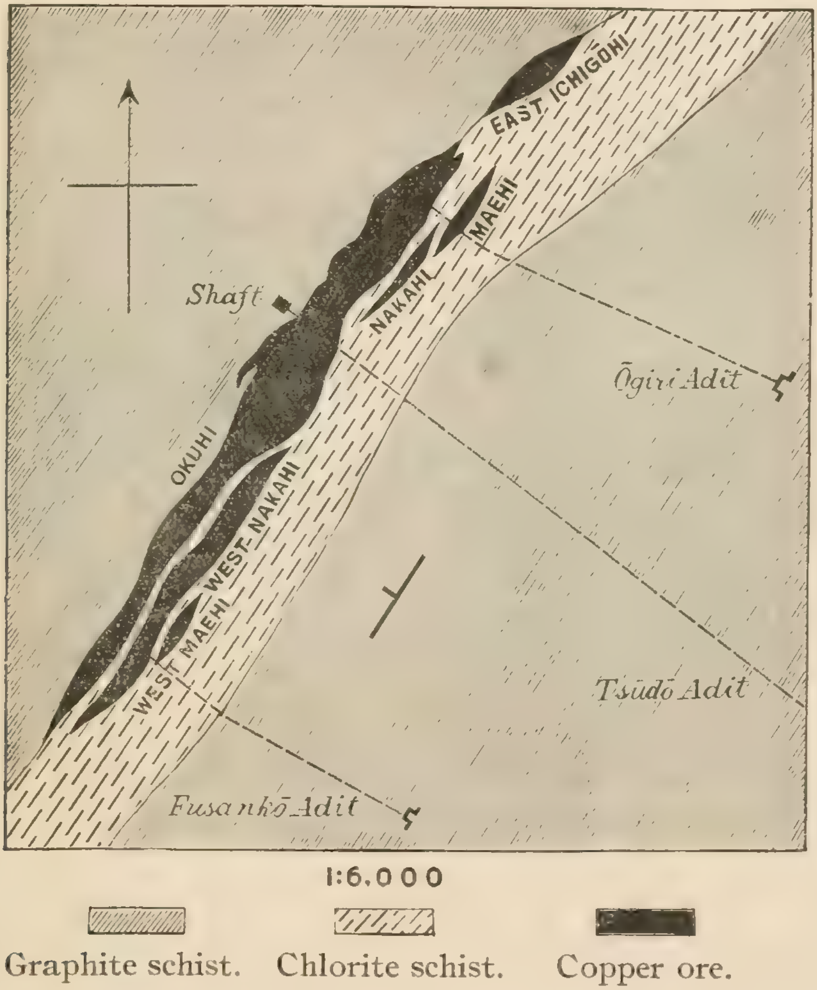
The ore deposit is epigenetic beds of pyritic ores (copper 3—8%). There are three horizons of beds, the upper horizon has two ore bodies, viz. East Ichigōhi and Okuhi, and middle has two bodies, viz. Nakahi



General view of Kune Copper Mines, looking N W.

and West Nakahi, and the lower has also two bodies, viz. Maehi and West Maehi. Among them, Okuhi is the largest one, being 45—100 ft. wide and 1,500 ft. long on the strike, but the depth is observed now as far as about 1,000 ft. Although the beds have gigantic bodies, they hide themselves under ground and their small iron caps only crop out to day light. On the deep part of the beds, they meet two synclinal step faults and one diagonal fault, with inverse dislocation.

Geological sketch of Kune Copper Mines.



The chief constituents of the deposit are pyrite and chalcopyrite in compact granular texture. Quartz is sometimes found with them. Occassionally magnetite occurs in separate layers. And frequently pyrrhotite is found in the pyrites.

Explanation of the Model of the Mines.

The model which is an exhibit of the Japan British Exhibition, shows the relief of the mines, the main levels underground, and the forms of the ore deposit. The green curved lines on the model indicate every 25 ft. contours on a scale of 1 : 300 horizontal and vertical. The red coloured bars show the main levels and shafts. The gilded masses are models of the real form of the ore bodies, and the yellow transparent planes explain the principal faults.

The colourings (black and blue) on the base show the geological distribution of graphite schist and chlorite schist respectively. Specimens of the schists and ores are arranged on the margins of the model stand.

This model clearly illustrates the size and peculiarity of the form of the ore deposit, as well as the relation between underground and surface, in a way that no maps and profiles could equal.

Mining.

Main Levels and Shafts. There are nine levels in the mines, of which two levels are important.

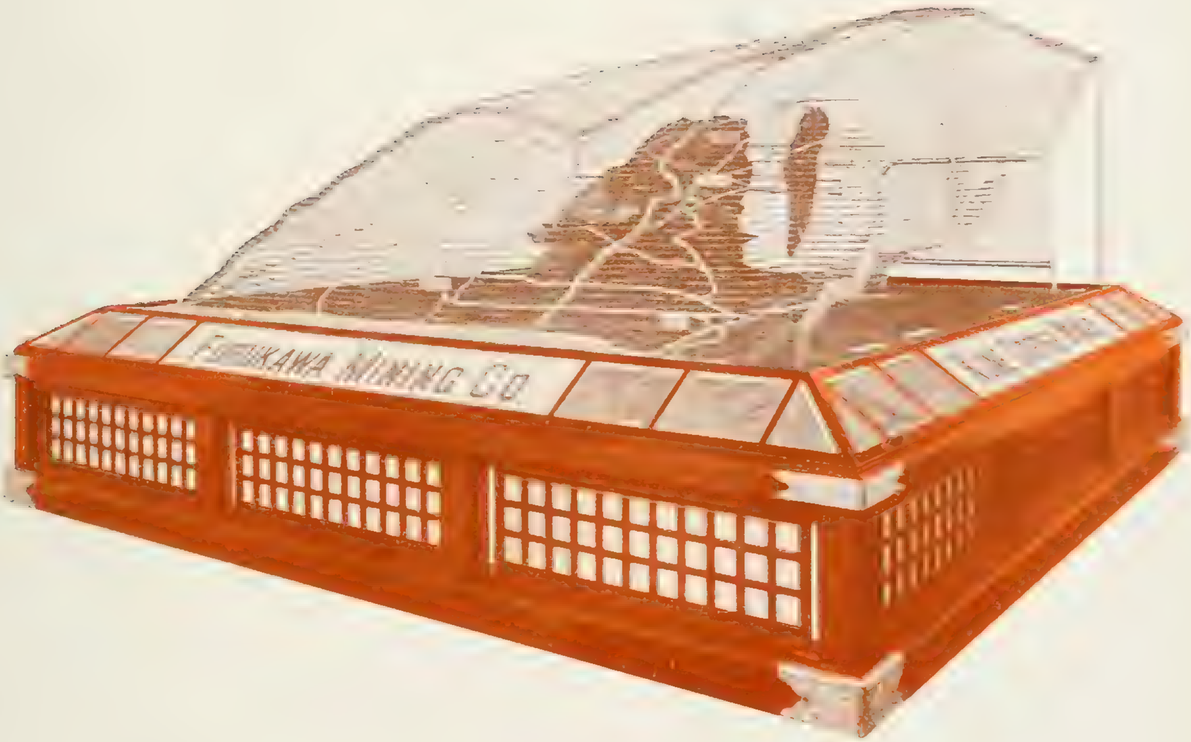
Tsūdō adit level :—This is the lowest, which is driven by cross-cutting, for the purpose of drainage and transportation as well as prospecting. It is driven 9 ft. wide, 8 ft. high and about 2,000 ft. long at present ; and double tracks are laid down.

Ōgiri level :—This is a crosscut at a height of 400 ft. above the former and is the most important level for transportation. Double tracks are also laid here. It is 8 ft. wide, 7 ft. high and about 700 ft. long.

Main shaft :—The shaft (5 ft. × 12 ft.) open on the Ōgiri level and reaches the Tsūdō level.

The upon portion of ore bodies of the Ōgiri level is now being worked, and the lower is reserved for the future working.

Working method. Overhand stoping is adopted in working. According to the thickness of the bed, the stoping is divided into two ways :—(I) stoping in the direction of the strike which is applied in the


FURUKAWA MINING CO.

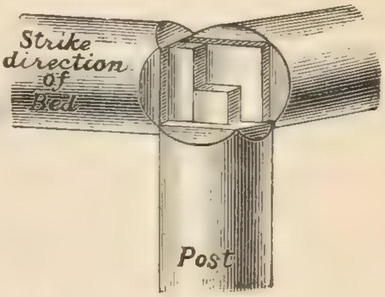
Model of Kune Copper Mines, looking the NW.

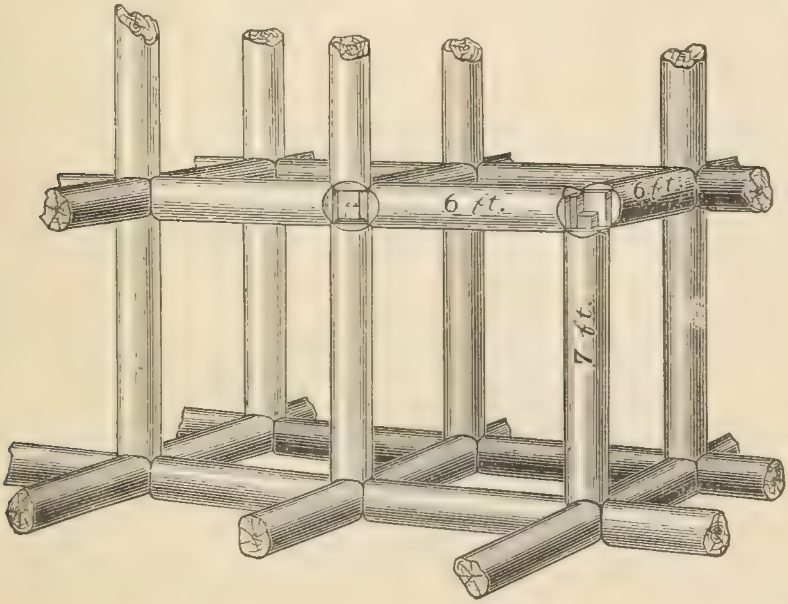
Manufacturers

K. Nakamura and S. Miyoshi

working places, where the bed varies 4 ft. to 8 ft. thick ; and (II) stoping in the horizontal direction at right angles to the strike which is used generally in the thicker part of the bed.

Timbering. For the timbering of levels and working place in the thiner part of the bed, simple cap-and-legs is used. But in the working place in the thicker part of the ore body, square-set system is introduced. Natural timbers of *Tsuga*, about a foot in diameter, are used here. The dimensions, shape, and joint of the square-set will be explained well in the following figures.





Transportation underground. The crude ores are transported to the spalling house by mine cars on rails. The rubbish in the working places is left behind as subsequent packing materials.

Cement Copper.

The mine water leaching through the old workings and stope fillings, contains copper and free sulphuric acid, then it is led over the dump to leach the weathered rubbish and save the copper. From the water, the cement copper is precipitated by scrap iron.

The annual production of cement copper is 60 tons of 50% copper.

Transportation.

The ores from the spalling house are brought by a ropeway to the bins built on the bank of the River Tenryū. The ores are loaded on boats and then are carried down to Tenryū traffic station of the Imperial Government Railway.

Innai Silver Mines.

(Annual production 3,600 tons of ore
containing 166,000 ounces of silver)

Location.

The Innai silver mines are in the town of Innai in Akitaken, and are within three miles of Innai station on the Imperial Government Railways.

The area of the concession is more than 1,500 acres.

History.

The mines were discovered by Sobei Murayama in 1606. In the latter half of the seventeenth century, they were owned by a lord of Akita, and have been in continuous work since then, having reached a productive capacity of 150,000 ounces of silver a year. In the beginning of Meiji they belonged to the Imperial Government and adopted the European method.

In 1884 the mines were purchased by the late I. Furukawa who improved and enlarged the capacity of mines to an annual yield 300,000 ounces silver with 0.6% gold. Now however, the mines have closed the reduction works up and are selling their ores to other reduction works thanks to railway facilities.

Geology and Ore Deposit.

The district of the mines consists of the Tertiary tuff, tuffaceous shale and tuffaceous sandstone as well as liparite and andesite, of which the last two are intruded into the Tertiary.

The ore deposit is quartz veins which traverse in all of the rocks. There are eight worked veins, viz. Hompi, Shihyakumaihi, Hompi-atsumi, Shihyakumai-atsumi, Asahihi, Taiseihi, Hayabusahi and

Nakayamahi. Among them Hompi and Shihyakumaihi are the biggest. The direction of the veins is divided into two, viz. (I) strike N 65° W, dip SW 80° and (II) strike N 75° E, dip NW 80°. The eastern part of Hompi, the western part of Shihyakumaihi, Hompi-atsumihi and Hayabusahi belong to the first; and the western part of Hompi, the eastern part of Shihyakumaihi, Shihyakumai-atsumi, Taiseihi, Nakayamahi etc. belong to the second. The Hompi is 3,000 ft. long, 3—15 ft. wide, and the Shihyakumaihi is 2,000 ft. long and 1—8 ft. wide.

The chief vein stuff is quartz. Rhodonite occurs in a considerable quantity and occasionally mangan-calcite is found. The argentiferous minerals are argentite, stephanite and pyrargyrite, sometimes native silver. Besides these minerals, chalcopyrite, pyrite, zincblende, and galena are found in variable quantities, so that they are abundant in Shihyakumaihi, and scarce in Hompi.

Mining.

Main Levels and Shafts.

Sosuidō adit level :—The adit opens near the dressing plant and is driven by the crosscutting at first, and then proceeds along Hompi vein, the champion lode of the mines. It is 10 ft. wide, 8 ft. high and 7,800 ft. long and is used for the purpose of drainage and transportation.

A crosscut toward Shihyakumaihi is driven from the place near the 1st. Yamaichi shaft and then a level is driven along the vein Shihyakumaihi for a length of 2,000 ft. The crosscut advances farther to explore the vein Asahi.

There are three levels above the adit level, driving along the veins Hompi and Shihyakumaihi, and eight levels below it along the Hompi. The lower part of the Shihyakumaihi below the adit level is now reserved for future working.

Miyuki passage :—It opens near the site of the mining office which is one mile from the adit and 230 ft. above the adit level. The passage is led to the junction of the adit level and the 1st. Yamaichi shaft, passing an inclined stepway. It is only the way for miners.

Entrance of Miyuki Passage.

General View of Innai Silver Mines.

His Majesty the Emperor of Japan honoured the passage with a visit in 1881, and since then it has been named the *Miyuki*, meaning the *Emperor's Visit* in memory of the honour.

1st. Yamaichi shaft :—The shaft (4 ft. × 13 ft.) is sunk from the surface as the middle of Hompi vein, and reaches a depth of 1370 ft., meeting with Sosuidō level at a depth of 320 ft. It is the most important shaft of the mines. An electric winding machine is equipped there.

2nd. Yamaichi shaft :—The shaft (4 ft. × 14 ft.) is situated at the eastern end of Hompi. It opens on Sosuidō level at a depth of 300 ft. and on the fifth level at a depth of 850 ft., having no connection with other levels. It is used only for ventilation.

Working method. Overhand stoping is chiefly adopted.

Transportation underground. The ores and rubbish below Sosuidō adit level are wound up to the level by the electric winding machine of the 1st. Yamaichi shaft, and those from Shihyakumaihi are brought by car to the station near the 1st. Yamaichi shaft. They are then transported by horse drawn cars to the adit.

Pumping and Drainage. All the mine water is drained out from the adit. The water from below the adit level is pumped up to the adit by two lifts. A Deane electric pump of 40 H.P. is equipped at the bottom of the 1st. Yamaichi shaft, and a Knowles electric pump of 30 H.P. at the third level.

Ventilation. Ventilation is chiefly done by natural draught. A part of the underground above the fifth level is naturally ventilated in such a way that the adit and the 2nd. Yamaichi shaft take in fresh air as a downcast and the 1st. Yamaichi shaft as the upcast during the whole year. Ventilation of the part below the fifth level is attained by the aid of electric fans.

Dressing.

As the crude ores possess a slight difference in specific gravity, the argentiferous minerals being equally scattered in the vein stuff, a mechanical separation can not be well applied.

The crude ores are crushed by Blake crushers and sized by trommels, then the oversize is picked into two classes, the rich and the poor. The poor and the undersize are stamped into fines by Californian stamps, the fines then are concentrated by Wilfley tables.

30 tons of crude ores containing 0.07% silver are treated, and 10 tons of concentrates containing 0.14% silver are obtained, a day.

Power.

The power is supplied by a hyoro-electric power plant at Kabayama, eight miles from the mines. The generating capacity is 500 H.P. of an alternating current at 5,500 volts.

Shakanoo Coal Mines.

Shiogashira Coal Mines.

Shakanoo and Shiogashira Coal Mines.

(Annual production 380,000 tons of coal)

Location.

The mines extend over the four villages of Katsuno, Kaida, Ōtani and Kasamatsu in Fukuokaken, and are located in the central part of the Chikuhō coal field.

The area of the concession is more than 1,200 acres, 90% of which bears the coal seams. The mines are divided into two, viz. Shakanoo and Shiogashira.

History.

The discovery of the mines was made in the beginning of Meiji. Subsequently the Shakanoo pit was opened in 1881 by Tokusaburō Sugiyama who first introduced a steam engine there in Chikuhō coal field. After the Shiogashira pit was first worked in 1896 by T. Sugiyama and Rempei Kondō, it came into the hand of the late I. Furukawa with the two mines of Shakanoo and Katsuno. Thanks to the brilliant development of the Shakanoo mines since 1904, they are now one of the largest ones in the coal field.

Geology.

The geological formation of the mines is the lower series of the Chikuhō coal-bearing Tertiary, which consists of shale, sandstone, conglomerate and coal seams. The tectonical structure of the Tertiary is a monoclinal whose strike is N 30° W and dip is 15° to E. The seams meet two diagonal faults striking N 50° E. The first of them is synclinal-normal and the second is anticlinal-normal.

The mines are being worked now in the west of the first fault, while the east is still not working. In the northern part of the Shiogashira mine, there is an intrusion of a kersantite, by which the coal is metamorphosed to a natural coke. The mines have more than 30 seams, among which the Kankan seam, Four feet seam, Nakajime seam and Five feet seam, are now worked.

Kankan seam . . . . 6 ft. thick.
interval 1 ft. . . . .
Four feet seam . . . . 6 ft. thick.
interval 20 ft. . . . .
Nakajime seam . . . . . 3½ ft. thick.
interval 15 ft. . . . .
Five feet seam . . . . 5⅓ ft. thick.

The Four feet seam and the Five feet seam are the best quality and behave a caking nature.

Analysis :

	water	volatile m.	coke	ash	sulphur
Four feet seam	1.42	44.04	50.64	3.90	0.19
Five feet seam	0.70	44.92	51.97	2.41	0.18

Mining.

Inclines and Headings.

Shakanoo Mine.

Main incline :—The incline (10 ft. × 6 ft. 5 inches) is driven along the dip of Nakajime seam to the 19th. heading, whence it goes toward the Four feet seam and the Five feet seam separately. It has 70 headings, and covers about 4,000 ft. in length, double tracks and an endless rope being equipped here. It is used for the downcast of the mine.

Yamanotani upcast :—It is used for the northern part of the mine. A fan is equipped at its mouth.

Migi upcast :—It serves for the southern part of the mine, and a fan is also provided.

Shiogashira Mine.

Main incline :—The incline (6 ft. 5 inches × 7 ft.) is driven along the dip of Five feet seam at a length of 3,200 ft. at present, cutting 53 headings at an interval of 60 ft. At the 12th. heading, it is branches off into the Four feet seam and proceeds 2,400 ft. long, cutting 40 headings to an interval of 60 ft. Along the whole length of the incline, a single track is laid down, and a hauling engine is equipped at its mouth. This incline is used for the hauling and the downcast of Shiogashira Mine.

Shiogashira upcast :—It is opened for the purpose of the upcast of the mine and a fan is set up at the mouth.

Working System. Post-and-stall is chiefly in use here and the long-wall system is partly adopted.

Pumping. The following pumps are equipped.

Shakanoo Mine.

Dean pump	225 H.P.	2
Turbine pump	65 H.P.	2
,, ,, ...	35 H.P.	3
Knowles pump	20 H.P.	4

Shiogashira Mine.

Turbine pump	100 H.P.	4
,, ,, ...	35 H.P.	1
Knowles pump	160 H.P.	2

Ventilation. The fresh air from the downcast, circulates through all the working places underground by the aids of stoppings, doors, air-crossings and several other means, and goes toward the upcast, where it is blown out by the fan.

Lighting. The main inclines, the pump rooms, and the watch houses are illuminated with electric lights. The miners carry Clanny lamps while the officials use Davy lamps.

Transportation underground. The won coal is carried to the heading from the working face by putters, whence it is transported to the main incline by mine cars, and then is hauled out to the dressing house on the surface.

Coal Dressing.

It is done by screening and sorting. The daily output is 700 tons in Shakanoo and 330 tons in Shiogashira.

Power.

There is a central boiler house in Shakanoo Mine. Some part of the steam is supplied to the hauling engine of Shakanoo and the rest to the electric generating plant whence the electricity is supplied to the pumps and ventilators of Shakanoo as well as Shiogashira.

Besides, in Shiogashira there is an independent boiler house ; the steam is sent chiefly to the hauling engine of the mine.

Transportation.

Here in Shakanoo and Shiogashira, there are two trafic stations of the Imperial Government Railway, specially built for loading the coal of the mines only. The coal is sent directly down to Wakamatsu and Moji, which are 21 and 32 miles from the mines respectively.

Shimoyamada Coal Mines.

Shimoyamada Coal Mines.

(Annual production 120.000 tons of coal)

Location.

The Shimoyamada Coal Mines are in the village of Kumada, and the town of Ōkuma in Fukuokaken, and are in the southern corner of the Chikuhō coal field.

The area of the concession is about 800 acres.

History.

In the beginning of the last century, the villagers of Shimoyamada used coal for their domestic purposes. In 1875, the coal was brought out to the Wakamatsu market for the first time. In 1986, the coal mines were transferred to the Imperial Navey Department, and in 1890, fell into the hands of M. Tōyama, and then in 1894, they were purchased by the late I. Furukawa.

Geology.

The district of the coal mines consistes of shale, sandstone, conglomerate and coal seam, which belong to the lower series of the Chikuhō coal bearing Tertiary. The Tertiary strikes generally N 50° W and dips 20° to N E, and meets several strike faults. Basalt intrudes into the Tertiary, and metamorphoses the coal to an anthracitic coal and a natural coke. Altogether there are more than 25 seams, of which the workable seams are three viz. Kōmori five feet seam, Doma eight feet seam and Kaigun eight feet seam.

Kōmori five feet seam . . . 6½ ft. thick.
interval 30 ft. . . . .
Doma eight feet seam . . . 6½ ft. thick.
interval 5 ft. . . . .
Kaigun eight feet seam . . 6 ft. thick.

The Kōmori five feet seam and the Kaigun eight feet seam are the best quality and have a caking nature.

Analysis :

	water.	volatile matter.	coke.	ash.	sulphur.
Kōmori . . .	1.48	40.42	55.27	2.83	0.48
Kaigun	3.10	33.52	55.67	2.71	0.74

Mining.

Inclines. There are many inclines and adits in the mines, of which Nakayama and Unabushi inclines are the largest.

Nakayama main incline :—The main incline is driven along the Kōmori five feet seam at the length of 2,100 ft. now, and a hauling engine with a single track is equipped there. The upcast is at a distance of 50 ft. from the former. The incline is for working of Kōmori five feet seam and Kaigun eight feet seam, which are connected with many stone drifts.

Unabushi incline :—It is driven along the dip of the Kaigun eight feet seam at a length of 600 ft. at present, for the working of Kaigun eight feet seam and Doma eight feet seam. A hauling engine is equipped.

Working system and Transportation underground. The working system and transportation are just about the same as those of Shakanoo and Shiogashira Mines.

Pumping. The following pumps are equipped here.

Tangye special pump	37 H.P.	7
,, ,, ,, ...	30 H.P.	1
,, ,, ,, ...	17 H.P.	2
,, ,, ,, ...	12 H.P.	2

Ventilation. The mines are naturally ventilated with the help of the ascending air in the upcast, which is due to the heat from the steam pipes conveying power down below.

Lighting. Davy and Clanny lamps are used here.

Coal Dressing.

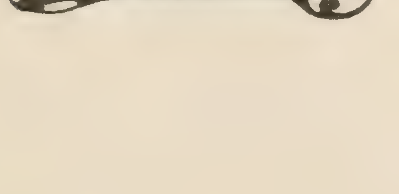
It is done by screening and sorting. The daily output amounts 330 tons.

Power.

Steam power is used for the hauling engines and pumps.

Transportation.

The station Shimoyamada of the Imperial Government Railway is built on the mines, so that the coal can be loaded into cars directly, whence they are transported to Wakamatsu and Moji.

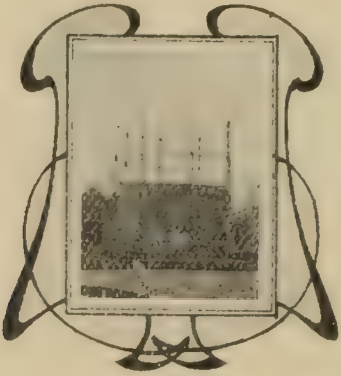


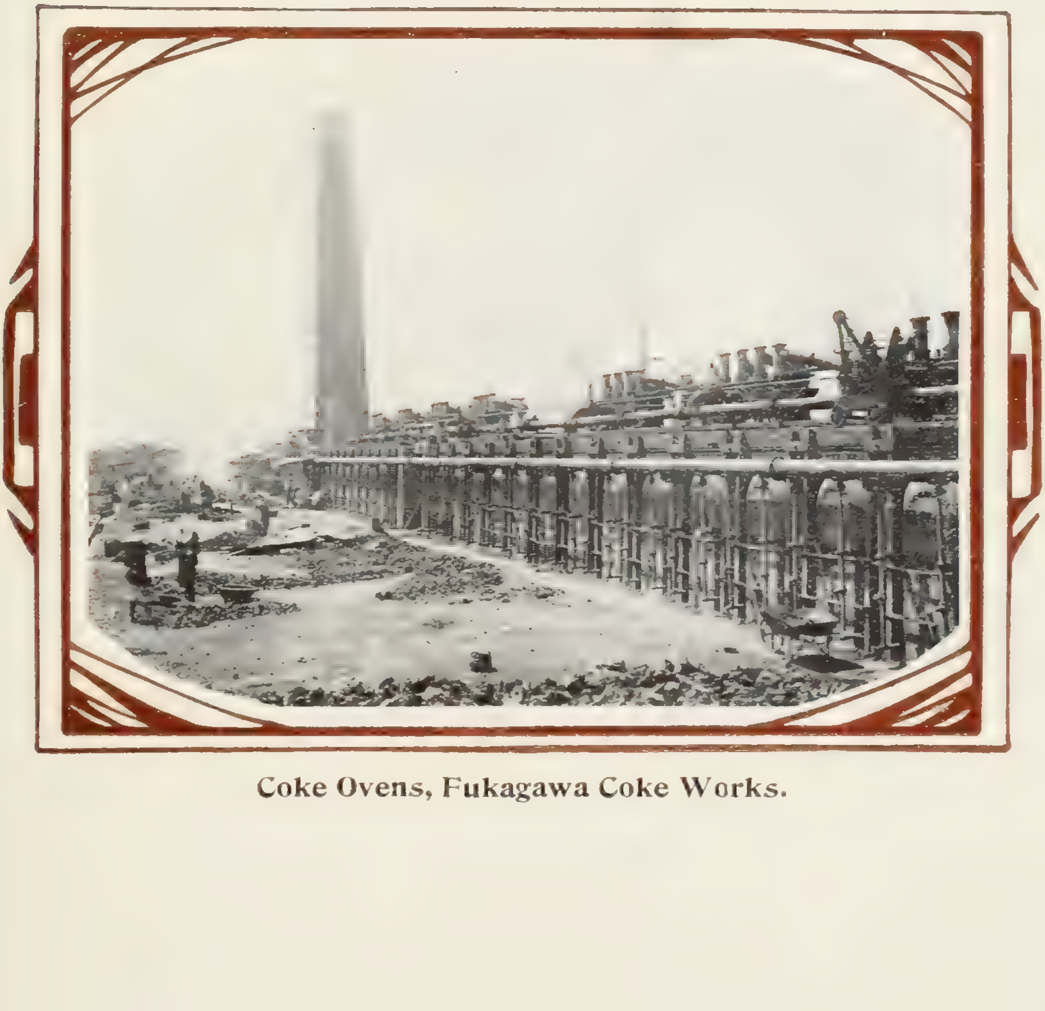
Fukagawa Coke Works.

The coke works are in the suburbs of the city of Tōkyō. They were built by the late I. Furukawa in 1890, for the purpose of supplying coke for the Ashio Copper Mines. There were 40 bee hive ovens here in this works, producing 5,000 tons a year at that time. The ovens were reconstructed in 1906, with the object of the extraction of gas, coal tar and sulphate of ammonia.

Manufacturing. The coals are washed and crushed, and sent to a charging box by belt conveyors. In the charging box, they are stamped by a machine, and are then racked in the ovens. After some thirty hours have passed, coke is discharged by a machine. While the coking is going on, volatile matters are exhausted by the exhauster to the gas holder, and coal tar and ammonia liquor are extracted from the crude gas, after treatment by a water condenser and a gas scrubber. Some part of the gas is sent back to the side-flues of the ovens for heating the wall of ovens, and the rest is utilized for lighting and power.

The works consume 50,000 tons of coal a year, from which they produce 30,000 tons of coke, 1,700 tons of coal tar and 400 tons of sulphate of ammonia.





Coke Ovens, Fukagawa Coke Works.

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